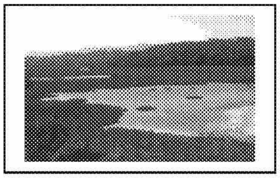
EXHIBIT 1



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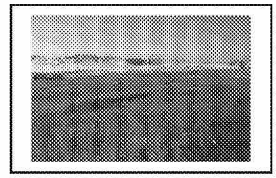

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Regulatory Analysis of Clean Water Act Section 404 and Rivers and Harbors Act Section 10 Jurisdiction at Redwood City Salt Ponds, San Mateo County, California

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Cargill Salt Redwood City Pond 10, west, January 2010

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EXECUTIVE SUMMARY

This report provides a critical regulatory analysis of U.S. Army Corps of Engineers jurisdiction (Clean Water Act Section 404, Rivers and Harbors Act Section 10) over commercial industrial salt ponds of the Cargill Salt Redwood City salt pond complex in South San Francisco Bay at Redwood City, San Mateo County, California. Key factual determinations for contemporary Corps jurisdiction under the Clean Water Act and Rivers and Harbors Act include:

- The permit history of the San Francisco District confirms that prior to the Clean Water Act, **the Corps in fact "traditionally" asserted Rivers and Harbors Act (traditional navigable waters) jurisdiction over the minor, nameless tributary sloughs and "banks" (salt marsh) of the tidelands of Westpoint Slough** (the site of modern Redwood City salt ponds) as portions of the traditionally navigable waterbody, San Francsico Bay. (Sections 3.0 and 4.0)

- The tidal channel beds within the diked marsh plain that forms the bed of the salt ponds were regulated as (and remain under current regulation and guidance) **lateral extensions of the traditionally navigable waterbody, San Francisco Bay**.

- The brines and salt pond beds (including slough beds) are **impoundments** of San Francisco Bay. Salt pond brines comprise vast volumes of navigable San Francisco Bay tidal waters that have been artificially managed to maximize evaporation, brine concentration, salt saturation, and salt crystallization, like natural salt-producing salt pans and salt ponds (Ver Planck 1958). Impoundments of navigable waterbodies are subject to Corps Section 404 jurisdiction. (Section 1.0).

- The salt ponds at Redwood City have "**significant nexus**" to the traditionally navigable waterbody of San Francisco Bay in modern times because all solutes (salts) of direct commercial and indirect biological values of national importance (including its designation to be included in a National Wildlife Refuge) are derived exclusively through **intake and impoundment** of navigable San Francisco Bay waters. (Sections 1.0, 4.0)

- The **original, existing dikes (levees) that created the salt pond impoundments** at Redwood City were authorized by the revocable Department of the Army (DA) permit under the authority of the Rivers and Harbors Act, issued to Stauffer Chemical Company in 1940.

- But for the (revocable) historic federal Department of Army permit to construct dikes and slough dams along Westpoint Slough, the beds and banks of the salt ponds would be continuous with those of the adjacent traditionally navigable waterbody, San Francisco Bay.

- The surface waters of San Francisco Bay would ebb and flow over the diked sloughs, banks and marsh plains but for the (revocable) historic federal Department of Army permits to construct dams across sloughs and dikes on the banks of slough.

- Rivers and Harbors Act jurisdiction is not extinguished by DA permits or sudden artificial changes, and the San Francisco District has asserted Section 10 jurisdiction at least over unfilled tidal sloughs (below the plane of former mean high water) behind dikes.

- The former bittern ponds were **converted** from concentrator ponds that were long used for industrial purposes in interstate commerce (salt production) (Ver Planck 1958; 1953 map of SF Bay Pond system) (Section 1.0)

- **Salt pond types such as concentrator, bittern, and pickle ponds are interconvertible at the discretion of the salt pond operator** (Van de Kamp 1986). Pond 13 is a former concentrator pond converted to bittern storage use after commercial sale of bittern was discontinued. (Sections 1.0, 4.0)

- **Bittern brines produced in the South Bay solar salt industry were themselves were sold in interstate commerce**, (Ver Planck 1958) and are susceptible to use for interstate commerce. (Section 1.0)

- Salt ponds in general are also susceptible for use, and have been used for commercial harvest and transport of **brine shrimp** sold in interstate commerce, under past lease agreement from the Refuge (USFWS 1992) (Section 1.0)

- The **Corps has established consistent modern precedents of asserting Section 10 RHA and Section 404 jurisdiction over salt ponds**, and explicitly over salt ponds with saturated and supersaturated brines and slough traces (crystallizers at **Napa**; Corps Permit No. 400258N, 2007; crystallizers in South Bay, Corps Permit No. 19009S98; Westpoint Marina, Pond 10 Redwood City, Corps Permit No. 22454S) **without exception since the 1980s**

- **The Corps has asserted "traditional" Section 10 jurisdiction** (prior to 1970s regulatory criteria for geographic jurisdiction under Section 10) over construction of dikes on tidal slough banks (marsh banks) and dams across tidal sloughs in San Francisco Bay for purposes of marsh reclamation (conversion to salt ponds and agriculture) **since at least 1904**.

- The Regional Water Quality Control Board (RWQCB) has documented **significant hydrologic connections between bittern ponds and the traditionally navigable waterbody San Francisco Bay**, due to spillage cracks, holes, and subsurface seepage of bittern into adjacent tidal marshes and sloughs, affecting water quality (Sections 1.0, 4.0).

1.0 Introduction

The purpose of this report is to provide a critical regulatory analysis of U.S. Army Corps of Engineers jurisdiction (Clean Water Act Section 404, Rivers and Harbors Act Section 10) over commercial industrial salt ponds of the Cargill Salt Redwood City salt pond complex in South San Francisco Bay at Redwood City, San Mateo County, California. This diked bayland site (including crystallizers, desalting ponds, wash ponds, bittern ponds, ditches) has been proposed for urban development as "Redwood City Saltworks" by Cargill and its partner, DMB Associates. This report reviews the physical condition of the Redwood City salt ponds, its history, permit and jurisdictional history, related documentation, and Corps regulations on jurisdiction.

The Corps has consistently asserted Clean Water Act Section 404 (CWA §404) jurisdiction extensively over salt ponds in San Francisco Bay since the 1970s, and it has also asserted Rivers and Harbors Act Section 10 (RHA §10) jurisdiction over portions of Redwood City salt ponds, tidelands, tidal channels (including non-navigable ditches and small tidal creeks) since at least the 1940s (see Section 3.0). Cargill Salt, and its predecessor, Leslie Salt Co., have disputed the Corps' assertion of jurisdiction, variously over some or all portions of the salt pond complexes in San Francisco Bay.

1.1. Site History

The salt ponds at Redwood City, like the majority of those of the South Bay in general, were originally constructed in the 20th century by converting tidal salt marshes and creeks to non-tidal impoundments that function as salt evaporation ponds (solar salterns or salt pans).
Since at least 1953, almost all of the existing salt pond system at Redwood City (with the exception of Pond 10, which was converted to a marina and habitat reserve after 2005) has been in continuous commercial industrial use in a configuration similar to its current condition (Ver Planck 1958, Plate 1; Figures 1-3, this report). Antecedent industrial salt ponds have been operating within the area occupied by the northern portions of the existing Redwood City salt ponds (most of the crystallizer area and Pond 10) since the beginning of the 20th century (Ver Planck 1958, p. 112).

The Redwood City salt pond system was amalgamated by Leslie Salt Co. in 1936. It consolidated some local salt works predecessors, primarily Stauffer Chemical Corporation and Leslie Salt Refinery Company, by 1936 (Ver Planck 1958,). The southern half of the existing Redwood City salt pond system between First Slough and Flood Slough (Ponds 9, 9A, 8W, 8E, 7A, 7B, 7C) was reclaimed by diking tidal salt marsh and damming tidal sloughs after 1943, and was operational by 1953 (Figures 1, 2; see also Section 3.0).

Cargill began decommissioning industrial salt production in the Bay Area beginning with its North Bay (Napa) salt pond system in the mid-1990s. The former Napa salt pond system is currently owned by the State of California. In the South Bay, Cargill sold either its industrial use rights (in ponds owned by the U.S. Fish and Wildlife Service Refuge) or fee title of most of the South Bay salt pond system to the U.S. Fish and Wildlife Service (San Francisco Bay National Wildlife Refuge Complex) or the State of California. Most salt ponds in San Francisco Bay are currently owned and managed by federal or state agencies. Most publicly owned salt ponds have been authorized to be converted from industrial salt production to different wildlife habitats (tidal mudflat, tidal marsh, and saline to hypersaline lagoons or ponds with damped tidal range), and many are currently in transition.

The Redwood City salt pond complex was connected to the Newark salt plant by brine pipelines that run under the bay, and received brines produced by East Bay salt evaporation ponds that concentrated bay intake water from tidal slough sources (Siegel and Bachand 2002). The existing Redwood City salt pond system appears to have no active industrial connections to bay intake and concentrator (evaporation) ponds in the South Bay salt pond system. The solar salt production system has been cut off at its source: remaining intake ponds have been converted to shallow lagoons with damped tides, and brine is no longer concentrated by evaporation to saturation. Former intake and concentrator ponds are also being converted to tidal mudflats in succession to salt marsh. Since the South Bay salt ponds ceased new production of brines circa 2004, remaining salt-saturated and near-saturated brines processed in the system have been concentrated in the last salt ponds that remained in industrial operation: the Newark and Redwood City plant sites (U.S. Fish and Wildlife Service and California Coastal Commission 2007). The brines contained at Redwood City, therefore, are remnants of former industrial production, not ongoing production.

1.2. Site Description

1.2.1. General description of the Cargill Redwood City salt ponds.

The Redwood City salt pond complex is privately owned by Cargill Salt. It was not included in the sale by Cargill of 16,500 acres (fee-title and mineral rights acquisition) to the Department of Interior and the State of California. All salt ponds within the Redwood City salt pond complex, however, were authorized by Congress for inclusion within the San Francisco Bay National Wildlife Refuge Complex (USFWS 1990; Public Law 100-556, 1988). The Redwood City salt pond system consists of approximately 1433 acres of salt ponds (levees, ditches, locks, and all enclosed types of basin that retain, convey, or form concentrated (hypersaline) brines derived from evaporation of bay water, with variable ionic composition.

The remaining salt ponds at Redwood City (including former crystallizers, bittern desalting and storage ponds, "pickle" or saturated brine ponds) are now (2010) disassociated from the extensive former bay intake and solar salt evaporator (concentrator) pond system that supplied them with fresh batches of brine. In the absence of an integrated bay intake and concentrator system, industrial salt production capacity is limited to residual brines within the remnants of the former South Bay salt pond system. The remaining system is, however, apparently in a serviceable condition and actively repaired and maintained. Operations and repairs activities are authorized under regional permits issued by the U.S. Army Corps of Engineers (permit 19009S98, issued in 1995 and presumably extended beyond its prescribed 10 year period; Cargill application for renewal submitted to USACE on April 15, 2008).

In 2002, the operational salt pond system at Redwood City ponds was mapped by Wetlands Research Associates (WRA 2002), showing rectangular crystallizer ponds numbered 1-9, bittern desalting pond 10, bittern storage ponds 9, 9A, and pickle (saturated brine) ponds 7A, 7B, 7C, 8E and 8W. The former salt pond types based on normal recent past industrial uses at the time (Fig. 2; pickle, bittern desalting, bittern storage, crystallizer) cannot be presumed to apply to the existing post-industrial conditions. Salt crystallizer operations, bittern, desalting, and pickle (saturated brine) ponds are described by Ver Planck (1958) and Siegel and Bachand (2002). Bay intake and concentrator (evaporation) ponds are not reviewed here because they are no longer part of the Redwood City salt pond system owned and managed by Cargill Salt. The Redwood City salt pond system also includes two dredge locks at ponds 9 and 9A, continuous with the perimeter levee system.

Crystallizer, pickle, and bittern ponds are normally periodically flooded with and drained of saturated brines through an artificial system of pumps, siphons, ditches, and water control structures. All the brines remaining in the salt pond system derived from evaporation of tidal bay water (estuarine sea water) in other parts of the salt pond system (bay intake ponds, evaporator ponds). The brines derived from San Francisco Bay tidal water today are essentially the same physically, chemically, and biologically as the natural saturated brines that produced halite and natural bittern brines in the historic Crystal Salt Pond (Fig. 9), San Lorenzo (Ver Planck 1951). The pickle ponds at Redwood City (7A-C) contained brines with dark orange-red hues in January 2010, indicative of *Dunaliella* and halobacteria (salt-tolerant natural single-celled green algae and bacteria) productivity and pigments at high salt concentrations (Javor 1989, Baye 2000).

Cargill Salt and its predecessor, Leslie Salt Co., have stressed repeatedly that all hypersaline brines of the solar salt industrial facility, expressly including bittern salts are "concentrated Bay water", with bittern distinguished merely as "concentrated bay water with sodium chloride removed" (Washburn 1985a). Cargill's legal representatives have declared that bittern storage ponds are not "waste treatment ponds" or "waste management systems", but holding ponds (Washburn 1985b).

1.2.2. Salt pond substrate

With the exception of some levees and berms that support vegetation or imported earthen fill, the bay mud substrate of Redwood City salt ponds generally consists of unvegetated non-tidal hypersaline flats composed of bay mud with variable salt or mineral film deposits. Bay mud is clay-silt estuarine sediment that dominates the surface of San Francisco Bay. Bay mud of salt pond beds is variably emergent or submerged under brines. Perimeter levees are subject to leaching with rainwater and tidal influence, reducing substrate salinity to levels that enable salt-tolerant wetland vegetation to establish (Fig. 8). The bay mud beds of the salt ponds were deposited naturally over the antecedent tidal marsh surface soils and tidal channels that were diked and impounded to form salt ponds (Ver Planck 1958). Relict tidal drainage topography, including First Slough (incorporated in ponds 4, 8E, 8W, 7A), has remained evident in aerial photography of the salt ponds from the 1940s to the present, including relict drainage patterns in multiple crystallizer beds.

The surface bay mud sediment in the salt ponds may be original tidal marsh sediment (bay mud with decomposed organic matter from vascular plants), or a veneer of naturally redeposited bay mud (resuspended fine sediment either from internal salt pond wind-wave erosion or suspended sediment load of former bay intake water). In the crystallizer beds, bay mud has been artificially redeposited by mechanical placement of wash pond mud (sediment removed from harvested halite by washing with saturated brines). The bay mud surfaces of salt ponds retaining saturated brines (including bittern, brines with high concentrations of potassium and magnesium salts) may also become mantled with precipitated halite (water-soluble sodium chloride solids or slush-like crystals suspended in saturated brine) as well as mineral precipitates of relatively insoluble calcium sulfate (gypsum). Halite precipitated in crystallizer beds was periodically harvested (along with some adhering bay mud), partially re-exposing underlying bay mud. (Ver Planck 1958).

There is no evidence that any salt pond beds at Redwood City include significant areas of any artificial substrates; the pond bed surfaces are composed of either bare bay mud, bay mud coated with precipitated halite, or bay mud coated with mineral precipitates from hypersaline brines.

1.2.3. Crystallizer salt ponds

Crystallizer and concentrator ponds are interchangeable salt pond types, depending on operational and internal structural modifications. Crystallizer ponds at Redwood City are distinguished from other salt ponds by their rectangular shape, wooden partitions, and beds that are periodically resurfaced (replenished with bay mud and re-smoothed) with wash pond muds to compensate for substrate loss during harvest of crystallized salt. The rectangular array of crystallizer ponds at Redwood City were depicted in the 1953 map of Redwood City salt production facilities (Ver Planck 1958, Plate 1), and were evidently converted from antecedent non-rectangular concentrator ponds visible in 1943 aerial photograph of the site (Fig. 1). Other crystallizers in the South Bay have been converted to concentrators in the past, such as A8 (Alviso; rectangular crystallizer beds evident in USGS topographic map, Milpitas quadrangle). Pond A8 was reported as a concentrator pond in Corps permit application environmental assessment documents by Cargill, permit 19009E98).

Crystallizer pond hydrology during the non-rainfall season is managed by artificial ditches and pumps and is designed for rapid filling with saturated brine (pickle) and emptying of bittern (brine supernatant following precipitation of sodium chloride/halite). During production, crystallizers are drained and filled with fresh saturated brine (pickle) two to five times (Ver Planck 1958). Halite deposits 4 to 6 inches thick form on the crystallizer bed.

Crystallizer pond hydrology is also significantly influenced by direct natural rainfall inputs in these artificial impoundments of bay water. Rainwater stratifies on the surface of dense concentrated brine, with little mixing except through strong wind-wave action (Ver Planck 1958). Heavy rainfall can cause strong dilution and overfilling of brines in crystallizer ponds, and sometimes induces a need for pumping to concentrator ponds to remove excess diluted brine (Cargill Salt 1996). Rainwater impoundment in salt ponds can be a major hydrologic control in wet years: in the wet winter of 1995, Napa pond 2A was breached under emergency conditions by California Department of Fish and Game (Jim Swanson, CDFG, retired; pers. comm. 1995) to relieve pressure in the salt pond system and prevent widespread levee failure due to salt pond internal overtopping.

Dilution of crystallizer brines during the winter-spring rainfall season is associated with development of pale to rich brine hues in the orange-red range (Siegel and Bachand 2002, cover photo;), indicating significant organic matter content and biological activity and productivity of *Dunaliella salina* and halobacteria (Javor 1989, Baye 2000).

Portions of crystallizer 4 and pickle pond 8E have recently been filled to an unknown elevation (date unknown) sufficient to create slipface side-slopes of the fill) by earthmoving equipment (Fig. 10). These modifications do not appear to correspond with repair and new work activities authorized under USACE permit 19009S98. The extent of fill modifications of the Redwood City salt ponds after cessation of industrial salt production is unclear.

1.2.4. Bittern salt ponds

Bittern ponds (bittern "storage" ponds) are former concentrator ponds used to store the supernatant saturated brine following precipitation of most sodium chloride from pickle in the crystallizers. Bittern was characterized by Leslie/Cargill salt's legal representatives as merely as "concentrated bay water with sodium chloride removed" (Washburn 1985). Bittern is transferred from crystallizers to bittern "desalting ponds", where residual sodium chloride (up to 12.5% of bittern at 30 Be; Ver Planck 1958) is precipitated. The desalted (sodium-reduced) bittern is composed of potassium and magnesium chloride and sulfate, with minor amounts of bromide and other seawater minerals.

Bittern storage in former concentrator or pickle ponds began after 1968, when the primary industrial consumers of bittern (caustic magnesium industry, Westvaco Chlorine Products Corporation and FMC) terminated its agreement with Leslie Salt (Washburn 1985a, b). Bittern is generated at a 1:1 ratio with sodium chloride salts, estimated at 800,000 tons of each salt type per year in the 1950s (Ver Planck 1958). Without an industrial consumer of bittern at rates commensurate with production, bittern storage became necessary by the 1970s, when State and Federal water pollution control laws regulated direct disposal of undiluted bittern in San Francisco Bay. Large salt evaporator pond acreage (e.g., ponds 12 and 13, Newark at Mowry Slough; ponds 9 and 9A, Redwood City) became dedicated to bittern storage. Most bittern produced since 1972 has been stored (Siegel and Bachand 2002). Bittern that was described as being in "temporary' storage for resale in the early 1980s (Washburn 1985b) persisted until the end of new brine production after 2005.

The relict tidal channel patterns typical of concentrator ponds were clearly evident in the beds of the Redwood City bittern ponds prior to 2007 (Fig. 2), despite the obscuring coverage of bittern solid salt deposits and bittern liquids. The tidal creek patterns corresponding with the antecedent morphology of tidal marsh are clearly visible in the 1943 aerial photograph (Fig. 1).

Bittern ponds may have subsurface hydrologic connection to the Bay, at least at times and in some conditions. Bittern storage ponds are converted concentrator ponds, and Ver Planck (1958) concluded that significant leakage occurs in concentrator ponds; the theoretical 10:1 ratio of concentrator to crystallizer pond area is in practice 15:1 because of pond leakage and rainfall inputs (Ver Planck 1958). Leslie Salt conceded at least one instance of direct tidal overtopping of a bittern pond levee (hydrologic input of tidal water) and backflow of "diluted" bittern to tidal waters of the Bay in December 1982 (Washburn 1985b). Bittern seepage through levees at Plummer Creek (Newark) on to adjacent tidal pickleweed marshes (where it apparently resulted in conspicuous dieback of vegetation and pooled bittern) was documented at up to 15 locations in 1984 by Regional Water Quality Control Board and U.S. Fish and Wildlife Service staff (RWQCB 1985). Bittern flow rates through cavities in levees were estimated at 5 gallons per minute, with seepage persisting for weeks. More recent (1999-2002) examples of bittern discharges to San Francisco Bay, ranging from thousands to hundreds of thousands of gallons, have been reported, including bittern overtopping levees due to high winds (Rogers 2007). Bittern ponds are therefore not completely isolated hydrologically from tidal aquatic habitats of San Francisco Bay: they may affect tidal water quality where leakage occurs, and they may be affected by extreme high tides where sufficient wave runup occurs near low or eroded levee crest segments.

Pond 9 was identified as a bittern pond as recently as 2002 (WRA 2002). Pond 9 in January 2010 was mostly drained of bittern, and was extensively excavated and filled. Its bed was converted from hypersaline mudflats with residual tidal creek topography to parallel rows of fill mounds that formed discontinuous ridges and troughs (Fig. 4). Ridges emerged approximately 1 ft to over 2 ft above the brine surface (Fig 4). Despite substantial rainfall, Pond 9 had a partly emergent bed over its western half (Fig. 5). The east end of the Pond 9 was holding some type of brine in the troughs and pits impounded between the linear mud mound ridges (Fig. 4). These unprecedented features for any bittern pond in either the South Bay or Napa salt pond systems are modifications that do not appear to correspond with repair and new work activities authorized under USACE permit 19009S98.

In the presumed absence of bay discharge of bittern (which requires long-term discharge of highly diluted bittern over years, under permit), it appears that bittern stored in Pond 9 has been remixed and recirculated in either pickle or crystallizer pond brines, or both. In any case, visual evidence that liquid bittern has been evacuated from Pond 9 (Fig. 5) indicates that it is now only nominally or historically a "bittern storage pond".

Former bittern (desalting) Pond 10 was converted to a marina and separate managed wildlife habitat area, under a separate permit issued by the Corps and BCDC (Fig. 6). Pond 10 lies outside the proposed Saltworks development area.

1.2.5. Pickle salt ponds

Near-saturated and saturated brines in pickle ponds are formed in batches from late-stage concentrator pond brines, and are pumped to crystallizer ponds (Ver Planck 1958). The depth of brine in the pond varies according to the stage of refilling or evacuation, and may be influenced by rainfall as well (Ver Planck 1958). Brine depths in the South Bay salt ponds in general is highly variable (Warnock *et al.* 2002), ranging from partly or completely emergent pond beds (exposure of bay mud; Warnock *et al.* 2002) to depths supporting abundant migratory shorebirds, dabbling and diving ducks (Takekawa *et al.* 2000).

The pickle ponds at Redwood City (7A-C) contained brines turbid with dark orange-red hues due to high concentration of *Dunaliella* and halobacteria indicating significant primary productivity (Javor 1989, Baye 2000). Relict tidal channel patterns are clearly evident in the beds of the Redwood City pickle ponds, corresponding with the antecedent morphology of tidal marsh in the 1943 aerial photograph (Figures 1, 2).

2.0 Natural salt ponds: comparison with industrial salt ponds

Salt ponds are not inherently artificial: the industrial salt pond system displaced its natural antecedents. San Francisco Bay historically supported natural salt ponds that generated halite deposits and saturated brines (Ver Plank 1951, Goals Project 1999). Hypersaline lagoons are widespread in arid and Mediterranean-climate barrier coasts of the world (Davis and Fitzgerald 2004, Woodroffe 2002). The largest natural salt pond near San Lorenzo (Alameda Co.), which is labeled "Crystal Salt Pond" in the U.S. Coast Survey T-sheet of 1857, (Fig. 9) has been interpreted geomorphically to be a natural impoundment of a tidal marsh and creek system, associated with a wave-deposited marsh berm or remnant of a low estuarine barrier beach (Atwater *et al.* 1979). The natural salt ponds were flooded by the high spring tides of June and July, and concentrated brine and produced halite up to 8 inches thick during neap tides of late summer and fall (Ver Planck 1951, 1958). The halite deposits of natural salt ponds were rapidly exhausted by commercial harvest by the 1860s, triggering the "improvement" of salt ponds for increased yield of salt. Natural salt ponds were the precursors of artificial salt ponds that evolved from "improved" bermed impoundments of natural pools to extensively diked tidal marshlands with dammed sloughs (Ver Planck 1958). The transition between natural and artificial salt ponds in San Francisco Bay occurred in the 1850s-1870s.

Specialized hypersaline microalgae (*Dunaliella salina,* the primary producer of salt ponds), and its primary aquatic invertebrate grazer brine shrimp, *Artemia franciscana*) inhabit modern salt ponds of San Francisco Bay. They originated in natural salt ponds, and colonized the industrial salt pond system (Larsson 2000). Primary production of *Dunaliella* also provides trophic support to brine flies (*Ephydra* spp.) a key prey item for some waterbird species foraging in late-stage salt ponds and their levees (Maffei 2000). Brine shrimp production was abundant enough (estimated adult population up to 4.5 billion; Larsson 2000) to support commercial industrial harvests from San Francisco Bay salt ponds (U.S. Fish and Wildlife Service 1992). Brine shrimp grow in hypersaline brines between 70 and 200 ppt, and survive as long-lived cysts (dormant resistant life-history stages, remaining viable for decades) in brines near saturation (U.S. Fish and Wildlife Service 1992, Larssen 2000). Brine shrimp are consumed by salt pond waterbirds including eared grebes, mallards, American avocets, Wilson's phalarope, whimbrels, California gulls, mallard, western and least sandpipers, willets, and greater yellowlegs (Larsson 2000). *Dunaliella salina* is ubiquitous in salt ponds of San Francisco Bay, and can remain photosynthetically active (alive and productive) near brine saturation (near 350 ppt). Only undiluted bittern may lack metabolically active *Dunaliella* (Javor 1989, Brock 1975).

Small salt ponds form internally within salt marshes of San Francisco and San Pablo Bays, in both remnant prehistoric salt marshes as well as historic-era salt marshes. Salt pans (variant spelling "panne", Fr.) are depressions or pools in undrained sections of salt marsh plains between tidal creeks (Chapman 1961, Pethick 1972), and also occur as undrained flats along the edges of alluvial fans or the landward edges of salt marsh plains (Baye *et al.* 2000, Baye 2000). Natural salt pans can evaporate in late summer, forming saturated brines and crystalline salt films or crusts, just as industrial salt ponds do. They similarly produce conspicuous pigmented "blooms" of *Dunaliella*, blue-green halotolerant bacteria, and brine flies. Their brines at various stages of concentration are essentially identical biologically and chemically with those of salt concentration ponds, pickle ponds, and crystallizer ponds of the industrial system. Natural brines also originate from tidal Bay sources, as do salt pond intake pond brines.

Because Crystal Salt Pond was destroyed before any detailed biological accounts (wildlife use) were prepared, it is uncertain whether playa-like dry salt pans were used by species that are currently federally listed as threatened or endangered under the Endangered Species Act, such as the western snowy plover, Pacific population (*Charadrius alexandrinus nivosus*) or the California least tern (*Sterna antillarum browni*). Western snowy plovers and California least terns inhabit the artificial salt ponds that replaced the Bay's natural salt ponds (Goals Project 1999).

3.0 Jurisdictional history of San Francisco Bay salt ponds

The Corps has a long and consistent history of asserting jurisdiction over the tidelands from which salt ponds were reclaimed, the process of salt pond reclamation, and the salt ponds and levee systems themselves. The earliest history of Corps regulation of salt pond construction occurred prior to the Clean Water Act, under the Rivers and Harbors Act of 1899. A brief and selective review of representative and key examples of Corps jurisdictional assertins (public notices, permits issued or denied, jurisdictional determination letters) over salt pond construction, salt pond operational activities, and the tidelands from which they were reclaimed, is presented below. This permit history is significant for analysis of contemporary jurisdiction over salt ponds because it shows how broadly the Corps interpreted its traditional (pre-Clean Water Act, pre-NEPA) jurisdiction over "navigable waters of the United States" in the "navigable waterbody" of San Francisco Bay and its tidelands.

3.1. Early historic assertion of Rivers and Harbors Act jurisdiction (traditional "navigable waterbody/waterway")

In contrast with modern Rivers and Harbors Act (RHA Section 10) regulations (33 CFR Section 328), which describes jurisdictional limits with explicit precision, the Corps San Francisco District had traditionally applied broad discretion in assertion of its jurisdiction over San Francisco Bay, including man-made ditches, small sloughs, tidal channels that were not named on official lists of "navigable waterways", and even construction of levees on "overflow lands" (tidal marsh) as well as dams across small tidal sloughs. The examples below provide counter-evidence to previous arguments by Leslie/Cargill Salt that the Corps narrowly asserted Rivers and Harbors Act jurisdiction over "navigable waterways" identified on official lists. The Corps even regulated overhead structures (above tide) that affected navigability. Examples of specific permit and public notice actions demonstrating traditional assertion of RHA Section 10 by the San Francisco District are reviewed below to provide a documented historic context for interpretation of "traditional navigable waters" in San Francisco Bay tidelands, relevant to "traditional navigable waterways" interpretation today (Section 3.2, Section 4.2.4.).

The Corps regulated reclamation of tidal marshes described as "overflow lands". The South San Francisco Land & Improvement Company submitted an application to "reclaim overflow land in the southern part of S.F. Bay at Point San Bruno, San Mateo County" on August 5, 1915. The permit was issued by the Division Engineer on August 23, 1915, citing "S.F. Bay (General)" as the affected waterway in the card file record of the permit action early in the Rivers and Harbors Act history in San Francisco Bay. Similarly, the Division Engineer authorized a permit on May 21, 1917 to "inclose [sic] with a levee a tract of about 1400 acres lying west of Petaluma River and north of San Antonio Creek, about 10 miles below the town of Petaluma" to W.O. Wright, citing "Petaluma River" as the affected waterway. This permit identifies the regulated location of fill (levee construction) on the banks of marshlands "lying west of the Petaluma River", and not in the navigable river itself.

On August 17, 1914, the Corps (Secretary of War) issued a permit to the Dumbarton Land and Improvement Company to "build a levee and close within the inclosure [*sic*] such sloughs situated between the left bank of Newark Creek on the north and the Santa Fe Pacific Railroad and Spring Valley pipe line on the south, as are not navigable [*sic*], in accordance with the plans and drawings attached…". This permits explicitly regulated sloughs tributary to the navigable waterbody of San Francisco Bay that were not navigable in fact, and were not named on official lists of navigable waterways. These marshlands later became part of the Leslie (Cargill) Salt pond system.

The most direct and site-specific evidence for early historic assertion of Rivers and Harbors Act jurisdiction over tidal marshlands at Redwood City is provided by the permit issued to Leslie Salt's predecessor, Stauffer Chemical Company, at the existing salt pond system on January 16, 1940. That permit expressly authorized levee construction (placement of dredged sediment) on the salt marsh banks, above tidal channels along Westpoint Slough and its tributaries, as well as across the First Slough: "…authorized to…construct an earth dyke [sic] or levee across and along the banks of First Slough and along the bank of Westpoint slough and an unnamed tributary thereof…". The Public Notice for this application, dated December 9, 1939, stated the proposal to "…construct about three miles of earth levee from the proposed dam extending along the southerly bank of Westpoint Slough."

Several critical conclusions about the Corps' assertion of Rivers and Harbors Act jurisdiction necessarily follow from the wording of the permit and Public Notice for the Stauffer Chemical Company proposal to construct salt ponds in tidal marshlands at Redwood City in 1939. First, it expressly authorized damming of "<u>unnamed tributary</u>" of Westpoint Slough, which indicates that the Corps asserted Rivers and Harbors Act jurisdiction over activities in waterways that were not included in any official lists of "navigable waterways" (since an unnamed tributary cannot be named in a list). Second, it expressly authorized construction of dikes <u>along banks of the slough</u>, not merely the dams across the mouths of channels. The Corps was in fact regulating discharge of fill on the marsh plain "banks" to construct levees.

The construction of salt pond levees was described in detail by Ver Planck (1958), who noted the necessity of placing dredged sediment in multiple lifts on the marsh so that the "crust" would not be broken and cause the new levee to collapse (Ver Planck 1958, p. 46-47). The "crust" is the cohesive pickleweed marsh plain with relatively high shear strength, more than ten times greater than compared with cordgrass marsh and unvegetated mud sediments studied in Palo Alto by Pestrong (1969). The location of approximately 40 ft wide salt pond levees (Ver Planck 1958) constructed at Redwood City, as elsewhere in San Francisco Bay, is generally inside of the edge of tidal creek banks delineated in U.S. Coast Survey T-sheets and USGS quandrangle maps at the time of their construction. These channel banks "black line" mapped features are generally interpreted as the Mean High Water line – as Cargill has asserted in past jurisdictional disputes and case law.

Thus, the regulated fill discharge on the high marsh bank capable of supporting a levee that was authorized in the Stauffer Chemical Company permit was <u>above</u> Mean High Water. This jurisdictional area is part of the <u>same marsh plain substrate and topography that forms the beds of the levee-enclosed salt ponds today</u>. Thus, the Corps previously asserted jurisdiction over "navigable waters" of San Francisco Bay <u>more broadly</u> than it does today 1986 Section 10 Rivers and Harbors Act regulations at 33 CFR Part 329. The Corps permit for Stauffer Chemical's reclamation of tidal marshes clearly indicates that the Corps traditional interpretation of its jurisdiction (pre-Clean Water Act) extended over "navigable waters" of San Francisco Bay that included its "unnamed tributary" sloughs and "banks" of tidal marsh plains. Cargill's past arguments that the Corps traditionally interpreted "navigable" waters narrowly and regulated only specific named, listed "navigable waterways" within San Francisco Bay contradict the site-specific permit history at Westpoint Slough's tidelands that became the Cargill Redwood City salt ponds. (Note: The aerial photograph from 1943 shows that the authorized levee construction along Westpoint Slough was not completed by that date: open tidal marsh plains and creeks extended from the open mouth of First Slough to Flood Slough).

Other Corps permits of the mid-20th century also confirm that the Corps regulated small, unnamed and even artificial tidal channels within salt marshes. Corps San Francisco District Public Notice 50-54 (10 May 1950) announced an application by Leslie Salt company of Newark, California, to "construct an earthen dam across the outlet of the borrow pit ditch…" for reclamation of tidelands south of the Dumbarton Bridge, near "Bellehaven" (near Palo Alto). This permit was part of the construction of the modern Redwood City salt pond system. The "borrow ditch", by definition, was clearly an artificial canal extension of San Francisco Bay as the parent navigable waterbody – not even a named tidal slough or a listed "navigable waterway". Borrow ditches were navigable by the Leslie Salt dredge, the Mallard, and smaller craft. The permit was issued on 29 May, 1950.

Corps San Francisco District Public Notice 55-36 (6 December 1954) announced an application by Leslie Salt Company to seek after-the-fact approval of a previously constructed unauthorized dam across Angelo Slough at its junction with Belmont Slough, San Mateo County. The Corps card file for permit actions reports that the permit was "refused", and cites the navigable "waterway" as "S.F. Bay (South)", rather than the sloughs where the dam was constructed.

Another permit action that demonstrates that the Corps traditionally regulated tidal sloughs that were too small to be navigable in fact (in their unimproved state) by commercial vessels, as well as adjacent tidelands, was granted to the Santa Fe Land Improvement Company to "fill the extreme upper end of Ellis Slough, and a small area adjacent to the high water line on the south side", citing "Richmond Harbor" as the affected waterway. The permit was issued on August 6, 1930. The card file indicates that authorized construction was completed on 2/7/31.

The Corps regulated activities that affected navigability of San Francisco Bay and its tributary navigable waterways, even when the activity was conducted above the reach of tides. The Corps issued a permit to PG&E Co. on January 29, 1940, to "install a 4,000 volt overhead power line crossing across the mouth of Gray Goose Slough, citing "Alviso Slough" as the waterway. The card file indicates that authorized construction was completed on 10/9/53. A similar permit to "construct an aerial power cable with a minimal vertical clearance of 25 ft above MHHW near Sears Point" over Tolay Creek (cited as the "waterway", but which was not listed by the Corps separately as a "navigable waterway") was issued to PG&E on October 20, 1953.

The permit history cited above establishes supports the following conclusions that are relevant to contemporary Clean Water Act and Rivers and Harbors Act jurisdiction and interpretation of "navigable waters of the United States":

- Long before the passage of the Clean Water Act and other federal environmental laws, the Corps' San Francisco District interpreted "San Francisco Bay", including unnamed tributaries and man-made tidal ditches, as extensions of this traditional "navigable waterbody". The Corps did not narrowly assert jurisdiction only over certain listed, named "navigable waterways" within San Francisco Bay.

- Long before the passage of the Clean Water Act and other federal environmental laws, the Corps' San Francisco District expressly regulated the construction of dikes on tidal marsh "banks" of tidal sloughs – specifically, at Westpoint Slough, the original dikes of the modern Cargill Redwood City salt ponds. The "banks" regulated as extensions of South San Francisco Bay (the navigable waterbody) were continuous with the tidal landforms that became the beds of the modern Redwood City salt ponds.

- The historic (and modern) RHA regulation of power lines located high above the navigable waterbody of San Francisco Bay indicates that the Corps' jurisdiction was not narrowly asserted within the tidal frame, but based on an "effects test" on the navigable capacity of San Francisco Bay. This conclusion is consistent with the Corps' historic regulation of marsh reclamation in tidelands, and damming of small unnamed tidal tributaries or ditches: diking these extension of the Bay, or removing dikes, indirectly affected its navigable capacity by altering tidal prism, tidal energy, consequently silting and shoaling (a process recognized following widespread marsh reclamation) that could interfere with navigations, as power lines can.

- The Corps traditionally asserted its regulatory authority over diking and damming small sloughs in tidal marshlands not only by issuing, but also by denying permits for after-the-fact fills (Angelo Slough example).

3.2. Modern assertion of Rivers and Harbors Act and Clean Water Act jurisdiction

Since the current Corps regulations on jurisdiction under Rivers and Harbors Act (RHA) Section 10 and Clean Water Act (CWA) Section 404 were published in 1986 (33 CFR Part 328 and 329; 33 USC 1344 and 33 USC 401 *et seq.*), the Corps' jurisdictional determinations became more explicitly precisely documented. The history of salt pond authorizations and enforcement actions since 1986 (current Corps permit regulations) are directly applicable precedents for contemporary salt pond regulation under Rivers and Harbors Act Section 10 and Clean Water Act.

The most recent permit issued for salt pond fill activities, including fills within intact former industrial commercial crystallizer ponds of Cargill (now owned and managed by the California Department of Fish and Game) dates from 2008 (Corps permit file no. 4000258N). The final jurisdictional determination report was approved by the Corps on April 21, 2008. This jurisdictional determination is particularly pertinent to Redwood City salt ponds because nearly the entire area over which the Corps asserted Section 404 jurisdiction as "non-wetland Waters of the United States" consisted of post-industrial crystallizer beds and post-industrial wash ponds that normally contained saturated or supersaturated brines. These ponds are substantively equivalent to the crystallizers and pickle ponds in Redwood City. The significance of this very recent and specifically applicable jurisdictional precedent cannot be overestimated. Notably, some jurisdictional "wetlands" were identified and mapped on levees internal to the crystallizer ponds.

The most recent regional permit issued by the Corps for all South Bay salt pond operations (Corps file no. 19009S98) was issued November 29, 1995 to Cargill Salt Division (Robert C. Douglass, Manager, Real Property). This permit expired on its own terms on July 31, 2005, but was provided a general permit condition (#1) allowing time extension. The permit covers activities "including operation, repair and new construction associated with the production of solar salt in the southern portion of San Francisco Bay" for the purpose "to sustain operation and production of the solar salt facilities…". At the time it was issued, activities related to decommissioning of salt ponds were neither proposed nor authorized. The permit was issued under authority of both CWA Section 404 and RHA Section 10. The explicit regulation of fill and excavation of crystallizer beds is shown at part 1.f of the permit. "Spot repairs and rehabilitation of crystallizer beds. This work will be accomplished with land based equipment". The explicit regulation of fill and excavation in salt pond interiors is also shown in authorization of new work with reporting and approval requirements for:

> 2.b) "Dredging of existing and new borrow ditches within the salt ponds…" and
> 2.c) "Dredging in salt ponds to allow the floating dredge to cross a pond, with the placement of dredged material on the bottom along the side of the dredged channel" to allow internal navigation; and
> 2.g) "Construction of new pumping donuts, internal coffer dams, and internal salt pond levees"

Finally, and also most recently, the Corps issued a permit (2008-00103S, January 23, 2009) to Mendel Stewart of the U.S. Fish and Wildlife Service San Francisco Bay National Wildlife Refuge Complex, for South Bay salt pond restoration Phase 1 permit activities in the approximately 4,155 acres of former salt ponds located at the Ravenswood (SF2), Alviso (A5, A6, A7, A8, A16, & A17) and Eden Landing Ponds (E8, E9, E12, and E13), for activities that will involve discharge of fill within the same salt pond interiors and levees that were formerly regulated under permits 19009E98 and 19009S98 issued to Cargill Salt.

Review of all modern permits issued for salt pond operation, repair, and new work in salt pond beds, ditches, internal berms, and perimeter levees, indicates the following:

- The Corps has consistently asserted jurisdiction over fill discharges in salt pond beds without distinction among salt pond types or water quality variables such as salinity or ionic composition. The Corps has explicitly regulated fill discharges in crystallizer beds, as shown in Section 404 jurisdictional maps (Napa) and in explicit narrative descriptions of activities authorized in crystallizer pond beds (South Bay).

- The Corps has consistently asserted jurisdiction over excavation/dredging within ditches and beds of salt pond interiors, without distinction among salt pond types or water quality variables such as salinity or ionic composition.

- The Corps has consistently asserted jurisdiction over placement of fill on interior levee benches and slopes below the (nontidal) high water line, on exterior levee slopes up to the high tide line.

4.0. Jurisdictional analysis of San Francisco Bay salt ponds

The following is a regulatory analysis of Clean Water Act Section 404 and Rivers and Harbors Act Section 10 geographic and activity jurisdiction over salt ponds. It applies the factual background information discussed in Section 1.0 to the fundamental jurisdictional criteria cited at 33 CFR Part 328 and Part 329.

4.1. Clean Water Act Section 404 jurisdiction (33 CFR Part 328)

4.1.1. Commerce clause nexus. 33 CFR §328.3(a)(1) defines "waters of the United States" under the Clean Water Act in terms of fundamental commerce clause nexus: "All waters which are currently used, or were used in the past, or may be susceptible to use in interstate and foreign commerce, including all waters which are subject to the ebb and flow of the tide;".

This basic criterion of past, present, or potential interstate commerce is fully satisfied by the pervasive commercial industrial origin, nature, and historic use of the Redwood City (and all San Francisco Bay and San Pablo Bay) salt ponds for the production, harvest, refining, and sale of crude solar salt. All portions of the solar salt production system are commercial industrial enterprises with an obvious and demonstrable history of interstate commerce – the marketing and sale of salt and salt by-products including bittern (sold as road dust suppressant, and formerly as raw material for the caustic magnesium industry) and brine shrimp harvested from salt ponds. Salt is the primary commercial product, and bittern and brine shrimp are secondary commercial products of solar salt production. There is no question that the Redwood City salt ponds (particularly crystallizers, which have no other purpose than to produce harvestable salt) produced in the past, and "are susceptible to use", for production of solar salt sold in interstate commerce.

The basic commerce clause nexus of industrial salt ponds is even more explicitly established by 33 CFR §328.3(3)(iii), "All other waters…the use, degradation, or destruction of which could affect interstate or foreign commerce including any such waters: (iii) which are used or could be used for industrial purpose by industries in interstate commerce;" .

The fact that salt ponds are "susceptible to use" for commercial production of brine shrimp in late-stage salt concentrator ponds also provides explicit commerce clause nexus at 33 CFR §328.3(3) "All other waters…the use, degradation, or destruction of which could affect interstate or foreign commerce including any such waters: (ii) from which fish or shellfish are or could be taken and sold in interstate or foreign commerce…". Even though "brine shrimp" are not traditional "shellfish" for human consumption, they are aquatic invertebrates harvested, processed (desiccated for preservation) and sold in a manner analogous with krill or small fish for fish meal.

In the case of salt ponds that have been publicly acquired (for the San Francisco Bay National Wildlife Refuge or the California Department of Fish and Game reserve system), there is no question that salt ponds "are or could be used by interstate or foreign travelers for recreational or other purposes". The San Francisco Bay National Wildlife Refuge Complex is one of the most heavily visited Refuges in the country because of its spectacular displays of migratory shorebirds. The primary purpose of a National (as opposed to a county, regional or state) Wildlife Refuge is to support interstate visitor recreational and educational conservation uses. The authorized boundary of Don Edwards San Francisco Bay National Wildlife Refuge expressly includes Tracts 165 and 166 (Redwood City salt ponds including current and past crystallizers, bittern, wash ponds, pickle ponds, desalting ponds) identified in the September 1990 Land Use Protection Plan of the U.S. Fish and Wildlife Service San Francisco Bay National Wildlife Refuge. On October 28, 1988, Congress passed Public Law 100-556, which increased the Service's acquisition authority for the refuge to a total of 43,000 acres.

It is important to note that the most significant federal nexus for jurisdiction over waters in Redwood City salt ponds is directly provided by their historic and essential interstate commercial industrial use, and secondarily provided by their demonstrated and federally authorized recreational potential for use. The presence of migratory birds, regardless of their number or frequency, is not essential to establish sufficient federal commerce clause jurisdiction in salt ponds.

Similarly, threatened or endangered under the Endangered Species Act, such as the western snowy plover, Pacific population (*Charadrius alexandrinus nivosus*) of the California least tern (*Sterna antillarum browni*) do nest on some portions of the former South Bay salt pond system, such as levee tops and dry concentrator pond beds. Because the distribution, frequency and abundance of these listed species at Redwood City salt ponds is unknown (or at least undocumented and unreported) under existing and recent past conditions, their importance in establishing commerce clause nexus may be relatively minor or insignificant compared with recent past commercial industrial use of the salt ponds.

4.1.2. Types of "waters of the United States" applicable to salt ponds

Listed among the "All other waters such as…" at 33 CFR §328.3(3) are "playa lakes", which are salt evaporation basins, such as the Great Salt Lake. The Redwood City solar salt ponds are hydrologically similar to playa lakes, as a result of their being artificially constructed impoundments of San Francisco Bay tidal marshes and tidal channels (see Section 1.0).

The fact that they are "impoundments of waters otherwise defined as waters of the United States under the definition" (33 CFR 328.33(4)), *i.e.,* they are impoundments of tidal waters from San Francisco Bay, is sufficient to bring them under jurisdiction of the Clean Water Act.

4.1.3. "Artificiality" of salt ponds and Corps Section 404 jurisdiction

The salt ponds of the south bay are composed of natural tidal marsh plains impounded by artificially constructed levees. The salt ponds are non-tidal impoundments of pre-existing, natural tidal wetlands including tidal channels extending the bed and surface of San Francisco Bay at the time of impoundment (section 3.0). The degree of modification of salt marsh to salt pond varies: the beds of crystallizer ponds, for example, are modified and maintained as flat, relatively impermeable beds

(Ver Planck 1958), while most ponds retain residual tidal marsh and creek topography, modified by internal ditches and berms.

Cargill has proposed various versions of *ad hoc* arguments that salt ponds are categorically "artificial" (rather than semi-artificial impoundments of antecedent tidal marshes), wholly transformed to a condition that renders them non-jurisdictional. Cargill has failed to cite any regulatory or policy basis for the theory that artificial impoundments of tidal wetlands are non-jurisdictional because they are "artificial". On the contrary, the definition of "waters of the United States" at 33 CFR §328.3(4) expressly includes "All impoundments of waters otherwise defined as waters of the United States…", which are by definition artificially diked or dammed enclosures of waters. Impoundments of tidal waterbodies (San Francisco Bay and all its lateral extensions or tributaries) or waterways defined as "navigable) are categorically jurisdictional (33 CFR 328.3(4)). Thus, "artificiality" *per se* cannot possibly in be a barrier to Section 404 jurisdiction. There are no jurisdictional disclaimers or exclusions in official policy guidance or regulation that apply to artificial waterbodies that otherwise meet fundamental Section 404 jurisdictional criteria.

The opinion of the Ninth Circuit Court of Appeals ruled in 1990 (Leslie Salt Co. v. United States and Save San Francisco Bay Association, February 6, 1990, CA No 89-15337) held that artificiality of salt ponds (specifically former crystallizers and calcium chloride pits in derelict salt ponds in Newark) poses no obstacle to Corps jurisdiction. The Ninth Circuit rejected a fundamental distinction between artificial and natural waters relevant to Clean Water Act jurisdiction.

33 CFR §328.5 expressly states "man-made changes may affect the limits of waters of the United States". To the extent that "man-made changes" are "artificial", and may affect the limits of jurisdiction rather than cancel jurisdiction altogether, artificial modification of wetlands does not nullify Corps jurisdiction. Furthermore, "artificial" salt ponds remain influenced by natural hydrologic influences of San Francisco Bay (significant seepage, tidal overtopping, wave run-up, as well as deliberate bay intake to salt ponds; see Section 1.0) as well as natural precipitation. The alleged categorical "artificial" status of salt ponds is itself an artificial, exaggerated, and arbitrary distinction that does not affect the fundamental jurisdictional status of the salt pond beds.

4.1.4. Extreme hypersalinity and Corps Section 404 jurisdiction

Cargill and its predecessor, Leslie Salt, have argued that some salt ponds are non-jurisdictional under the Clean Water Act because of the extreme hypersalinity (saturated brines) of their waters. This argument is fallacious. Neither the Clean Water Act nor its regulations establish any upper limit of salinity, or any compositional threshold for aqueous solutions that may be treated as "waters of the United States". The definition of "waters of the United States" at 33 CFR §328(a)(3) includes haline (marine salinity) and hypersaline (higher than marine salinity, with ionic composition differing from sea salt, typical of inland saline soils and waters) aquatic habitats, such as "mudflats", "wetlands" (including tidal marshes that become hypersaline), and "playa lakes"(which are by definition naturally saline or hypersaline, like the Great Salt Lake, a jurisdictional waterbody). Some highly beneficial natural and managed aquatic habitat functions for particular water-dependent wildlife depend on upper ranges of hypersalinity (Takekawa *et al.* 2000, Warnock et al. 2002, U.S. Fish and Wildlife Service 1992, Goals Project 1999). Natural waterbodies such as the Great Salt Lake, and historic San Francisco Bay natural aquatic habitats such as Crystal Salt Pond, regularly developed hypersaline and even saturated and supersaturated brines resulting in salt crystallization and precipitation of thick halite beds (Ver Planck 1951).

The Section 404(b)(1) guidelines expressly identify potential adverse impacts of restricting saline water on salinity-dependent biota (40 CFR §230.25, Salinity gradients), and considers the environmental context of salinity in terms of organism adaptations and natural patterns and processes of salinity gradients. Thus, Section 404 does not presume that salinity per se is contrary to the overall aims of the Clean Water Act. Neither the Corps nor EPA have established any guidance, policy, or regulations that establish a non-arbitrary, scientifically supported upper limits of aqueous salinity that may be considered thresholds for converting "waters of the United States" to a non-jurisdictional state. Such a threshold would be absurd, because it would allow natural or artificially manipulated saline waters to pass in and out of Clean Water Act jurisdiction based on short-term salinity fluctuations, or artificial salinity regimes intended to defeat jurisdiction (see Section 4.1.5, below). There is no regulatory or Corps/EPA policy basis to justify any salinity or hypersalinity level as a barrier to Section 404 jurisdiction.

Cargill's (Leslie Salt Company's) arguments that derelict Newark crystallizer ponds were non-jurisdictional aquatic features under the Clean Water Act merely because of their artificial origin were rejected by the Ninth Circuit Court of Appeals.

4.1.5. Conversion of salt pond types and brines, and Corps Section 404 jurisdiction

A corollary of Cargill's theory that saturated brines are not jurisdictional waters of the United States is that the geographic salt pond areas impounding saturated brines are themselves non-jurisdictional – implying that the allegedly non-jurisdictional waters could leave an imprint of jurisdictional exclusion on certain geographic areas. This is also a fallacy. It leads to the absurd conclusion that the artificial transfer of saturated brines among salt ponds could eliminate geographic jurisdiction at the whim (or with intent to circumvent regulation) of brine management within the system. Informal legal opinion and factual determinations prepared by the California Attorney General in 1986, prepared in response to inquiry from the San Francisco Bay Conservation and Development Commission (BCDC) about the extent of its "salt pond" jurisdiction, are applicable to some aspects of Section 404 Clean Water Act jurisdiction:

> Finally, we note that it is not difficult to convert salt ponds from one type of use to another. For example, certain bittern ponds on the Baumberg Tract have been converted to and used as concentrators and pickle ponds. See June 10, 1985 letter from Raymond Thingaard to Steve McAdam, BCDC, p. 2; see also Dorn, Salt, Univ. of California, Berkeley, November 161982 (unpublished manuscript), noting that "crystallizing ponds can easily be converted to concentrator ponds if needed"). If BCDC's jurisdiction were construed as being limited to only one type of pond (for example, concentrators), then certain areas might pass in and out of BCDC's jurisdiction depending solely upon the fortuitous production patterns of the salt making company. We doubt that the legislature intended to make BCDC's jurisdiction so variable and uncertain. (Van de Kamp 1986, p. 13)

The same principle would apply to Clean Water Act jurisdiction: if the geographic area of jurisdiction depended on the particular range of concentration or ionic composition of a brine solution, salt ponds would pass in and out of Section 404 jurisdiction within and among years, based on the discretion (or whim, or intent to circumvent regulation) of the salt pond operator. In theory, if the Corps arbitrarily decided that bittern ponds and bittern brines were too rich in potassium and magnesium, and too poor in calcium to be "waters of the U.S." the salt pond operator could degrade environmental quality of a salt pond by flooding it with bittern, and be rewarded with elimination of Clean Water Act Section 404 jurisdiction and its environmental protections.

Similarly, if the Corps arbitrarily decided that crystallizers were too salty to be "waters of the U.S.", then the salt pond operator could artificially draw down and dry out any salt pond to claim elimination of Section 404 jurisdiction. Theoretically, jurisdiction over the entire salt pond system could be eliminated by sequentially moving (arbitrarily 404-deregulated) bittern batches through the salt pond system, "poisoning" jurisdiction iteratively (in effect, polluting away jurisdiction, the inversion of regulatory intent), to escape Section 404 by converting ponds to non-aquatic conditions without regulation. This, of course, would be an absurd and arbitrary interpretation of the Corps regulatory program under Section 404; yet it is the logical consequence of disclaiming 404 jurisdiction over bittern and crystallizer ponds because of their concentration and ionic composition. This would be analogous to allowing a landowner to eliminate Corps jurisdiction by eliminating wetland vegetation, contrary to Corps policy on "normal circumstances" (RGL 86-9) expressly aimed "to respond to those situations in which an individual would attempt to eliminate the permit review requirements of Section 404 by destroying the aquatic vegetation".

Another logical consequence of arbitrary assertion of a salinity or brine composition threshold for CWA Section 404 jurisdiction is that hypersaline waters with naturally important value under the CWA, such as the Great Salt Lake, salt pans of tidal marshes in San Francisco Bay during late summer, and many western playa lakes would pass in and out of jurisdiction – but mostly out. Similarly, in theory, the natural historic Crystal Salt Pond of San Francisco Bay would never have been eligible for protection under Section 404 under this theory.

The salt pond areas dedicated at any given time to bittern storage or crystallizer brines are entirely at the discretion of the operator, particularly during the era of post-industrial decommissioning (phase-out) of commercial salt production. Because the location of different brine types are purely artifacts of operational discretion, and not inherently attached to the geographic salt pond area, they cannot reasonably be used as an instantaneous basis for assertion or disclaimer of Clean Water Act jurisdiction, following the reasoning of the California Attorney General in 1986.

4.2 Rivers and Harbors Act Section 10 jurisdiction

4.2.1. General definition of navigable (in law) waters of the United States: commerce clause and transport

Essentially similar "commerce clause" requirement of the Clean Water Act applies to the general Rivers and Harbors Act (RHA) Section 10 definition of navigable waters of the United States: 33 CFR §329.4 reiterates the fundamental federal jurisdictional requirements for either "ebb and flow of the tide", or present, past, or susceptibility for use to transport interstate or foreign commerce. The key difference for RHA jurisdiction is its specific requirement for transport (navigation for commerce), rather than indefinite commercial use. **RHA determination of "navigability, once made, applies laterally over the entire surface of the waterbody, and is not extinguished by later actions** or events which impede or destroy navigable capacity" under this general definition.

Thus, as "San Francisco Bay" is a "navigable waterbody", as determined by the Corps, RHA jurisdiction extends laterally over the entire surface of the waterbody, and is in principle inextinguishable even by dikes or dams. The presence of the Port of Redwood City adjacent to the Cargill Salt plant at Redwood City verifies that San Francisco Bay remains navigable in fact and in law in the immediate vicinity of the salt production facility.

Moreover, 33 CFR §329.6 clarifies that any historical use of commercial vessels of any size, including canoes or other small craft capable of transporting commercial goods, are sufficient to establish navigability under Section 10. The Redwood City salt ponds are "susceptible for use" by shallow-draft brine shrimp harvest boats that have historically operated in concentrator ponds within the South Bay salt pond system (U.S. Fish and Wildlife Service 1992). Concentrator salt ponds productive of brine shrimp may be converted from any pond type (See Section 4.1.5), and the Redwood City salt ponds include both land access and dredge lock access for small boats to operate within them. Brine shrimp products are sold in interstate commerce. Therefore, historic brine shrimp harvest and navigation in salt ponds establishes that they are "<u>susceptible</u> for use to transport interstate or foreign commerce", regardless of whether or not brine shrimp have in the past been harvested from Redwood City salt ponds specifically.

Furthermore, the salt pond beds include unfilled portions of diked tidal creeks that were originally subject to the ebb and flow of the tide, providing "navigable in law" status that is not extinguished by later actions such as diking (33 CFR §329.9(a). The original condition of the diked tidal creeks does not limit the current extent of RHA Section 10 jurisdiction if navigable capacity is improved by artificial means. Impoundment of (concentrated) bay water within the salt ponds, increasing water depth, constitutes an "improvement" or "artificial aid …used to make the waterbody (diked historic tidal sloughs) suitable for use in navigation" (33 CFR §329.8). Private ownership of the salt pond does not preclude extension of RHA Section 10 from the diked tidal creeks over the entire "improved" brine shrimp boat-navigable water surface of the pond interior (33 CFR §329.8(a)(3)). Thus, the combination of brine shrimp harvest and transport potential in salt ponds, and diked historic tidal slough beds of Redwood City salt ponds with artificially impounded and increased depth of tidal-source bay water over diked slough beds, is sufficient to extend RHA Section 10 jurisdiction over the entire salt pond bed surface (excluding levees and berms).

Unlike industrial dredge lock and dredge navigation within salt ponds, which are components of the commercial production of solar salt, brine shrimp boat harvest operations are essentially commercial transport of goods from the point of harvest to commercial industrial processing and eventual interstate sale (like fishing boats or historic timber boats loaded with logs floated down rivers). Their impact on the extent of Section 10 jurisdiction behind dikes is unique to salt ponds.

4.2.2. Geographic limits of jurisdiction

The navigable waterbody of San Francisco Bay extends laterally over the entire surface of its bed, including sloughs and tidal creeks that were large enough to allow any type of commercial navigation (33 CFR §329.4). The shoreward limit of Section 10 geographic jurisdiction "extends to the line on the shore reached by the plane of mean (average) high water". 33 CFR 329.12(a)(2). This determination is reinforced by the general RHA Section 10 jurisdiction over bays and estuaries (33

CFR §329.12(b)), which also extends to the entire surface and bed of all waterbodies subject to tidal action:

> Jurisdiction thus extends to the edge (as determined by paragraph (a)(2) of this section) of all waterbodies, even though portions of the wterbody may be extremely shallow, or obstructed by shoals, vegetation or other barriers. Marshlands and similar areas are thus considered "navigable in law", but only so far as the area is subject to inundation by the mean high waters. The relevant test is therefore the presence of the mean high tidal waters…"

Dikes that impound tidal creeks, or choke the ebb and flow of the tide in (dammed) sloughs that were historically continuous with San Francisco Bay, do not extinguish Section 10 jurisdiction:"…an area will remain navigable in law" even though no longer covered with water, whenever the change has occurred suddenly, or was caused by artificial forces intended to produce that change." 33 CFR §329.13.

The reasoning in these regulations was the basis of the San Francisco Corps District's pioneering interpretation of Rivers and Harbors Act jurisdiction in unfilled tidal sloughs behind dikes (PN 71-22, June 11, 1971, PN 71-22(a), January 18, 1972), modified to reflect tidal datum limits (Mean High Water rather than Mean Higher High Water) of geographic RHA Section 10 jurisdiction established by case law on jurisdiction over San Francisco Bay salt ponds. Even before these Public Notices, it is clear that the San Francisco District had been asserting its RHA authority broadly over activities that even indirectly affected navigable capacity of San Francisco Bay (Section 3.0, this report).

4.2.3. Determination of navigability: "Navigable waterway" lists and geographic jurisdiction over waterbodies

The navigable-in-law status of the waterbody San Francisco Bay under RHA Section 10 is established by its nature as "bay or estuary", and the exhaustively extensive nature of Section 10 jurisdiction (33 CFR §329.12(b)). The absence of a particular tributary slough or creek in a list of "navigable waterways" within San Francisco Bay does not indicate a lack of Section 10 jurisdiction (33 CFR §329.16(b)). The Corps San Francisco District first prepared lists of "navigable waterways" in 1932, but in fact asserted RHA jurisdiction over portions of San Francisco Bay outside of the listed waterways before, during and after lists were prepared, including unnamed tributaries and even artificial borrow ditches (Section 3.0, this report). Corps permit records prior to the 1970s variously identify "San Francisco Bay" or the nearest named waterway (listed as "navigable" or not) as the "waterway" of permit and Public Notice actions. The Corps in fact did <u>not</u> use the lists of navigable waterways as a geographic boundary of its RHA jurisdiction (Section 3.0). The 1932 list of "navigable waterways" omitted some of the largest tributaries of San Francisco Bay and San Pablo Bay that were used for contemporary navigation and were in fact regulated by Department of Army authorizations, including Novato Creek, Coyote Creek Guadalupe River, Newark slough, Montezuma Slough, Belmont Slough and Steinberger Slough. The list also omitted explicit reference to San Francisco Bay, San Pablo Bay, Suisun Bay, and their connecting Straits. It would be absurd and historically incorrect to interpret their absence from lists as an affirmative disclaimer of RHA jurisdiction.

4.2.4. "Traditional" navigable water status and "significant federal nexus" of historic tidelands and tributary sloughs of Westpoint Slough, San Francisco Bay: Corps permit history

Current Corps and EPA national guidance on jurisdictional determinations (USEPA and U.S. Department of Army 2007) refines criteria for preparing fact-specific analyses to determine whether wetlands and other waters that otherwise meet standard Corps jurisdictional criteria have a "significant nexus" with a "traditional navigable water". The national criteria guidance applies primarily to inland (nontidal) wetlands and fluvial drainage systems and floodplains, but the pre-Clean Water Act Corps permit history of tidelands that became the Redwood City salt ponds, and similar tidelands and sloughs, provide site-specific relevant tests of current national jurisdictional guidance influenced by SWANCC/Rapanos case law.

The Redwood City salt ponds are not inland "isolated" waters: they are diked tidelands of San Francisco Bay itself, separated by dikes revocably permitted by the Corps in 1940. The original, existing dikes (levees) that impound concentrated San Francisco Bay waters at the Redwood City salt ponds along Westpoint Slough were authorized by the revocable Department of the Army (DA) permit under the authority of the Rivers and Harbors Act, issued to Stauffer Chemical Company in 1940. But for the (revocable) historic federal Department of Army permit to construct dikes and slough dams along Westpoint Slough, the beds and banks of the salt ponds, and their water surfaces, would be continuous with those of the adjacent traditionally navigable waterbody, San Francisco Bay. The tidal waters of the Bay would ebb and flow through the diked baylands of the salt ponds but for the revocably permitted slough dams and salt marsh dikes.

It is undisputable that the Corps issued (revocable) permits to construct dams across small unnamed tidal sloughs and ditches, and levees on "banks" (high tidal salt marsh) bordering tidal sloughs of South San Francisco Bay at Westpoint Slough (Section 3.0). It is thus also indisputable that the Corps in fact historically ("traditionally") interpreted all these tidelands and sloughs as part of San Francisco Bay as a navigable waterbody, prior to the Clean Water Act and later regulatory refinements of Rivers and Harbors Act jurisdiction. The permit history cited in Section 3.0 demonstrates that the Corps did not in fact restrict assertion of its "traditional" (pre-Clean Water Act) jurisdiction to selected listed, named waterways within San Francisco Bay or exclude nameless tidal sloughs, ditches, or tidelands from its "traditional" jurisdiction over the whole of San Francisco Bay. The physical and permit history of the diked tidelands that comprise the Redwood City salt ponds demonstrate that the ponds are themselves an extension of a traditional navigable waterbody. Rivers and Harbors Act jurisdiction is not extinguished by DA permits or sudden artificial changes in the condition of a navigable waterbody.

Even if the historic permit record of the Redwood City salt ponds did not establish that they were in themselves a portion of San Francisco Bay as a traditionally navigable waterbody, an analysis of federal "significant nexus" to contemporary San Francisco Bay reveals that its factual connection to the Bay remains ineradicable and extensive:

- The salt ponds are essentially impoundments of San Francisco Bay waters: they could and would not exist except as impoundments of San Francisco Bay waters. The active industrial manipulation of concentrated bay waters by evaporation and water management does not alter their source.

- The solutes (salts) in the salt ponds that exclusively provide the economic (direct interstate commerce) value of industrial salt ponds derive exclusively from San Francisco Bay. These salts include both halite (sodium chloride, common salt) and bittern, both sold for industrial and other commercial uses.
- The solutes (salts) in the salt ponds that exclusively provide the biological basis for primary productivity (salt-loving microalgae, bacteria), and the organisms themselves, were derived exclusively from San Francisco Bay sources.
- The entirety of the Redwood City salt ponds were authorized by Congress in 1988 to be included in the San Francisco Bay National Wildlife Refuge, which is established to conserve the unique water-dependent fish and wildlife resources of national importance in San Francisco Bay.

In addition to the fundamental hydrologic connectivity between salt ponds and the bay provided by the salt pond intake and concentrator pond system that created all the brines at Redwood City, the following secondary hydrologic connections have been documented in San Francisco Bay:

- The Regional Water Quality Control Board (RWQCB) has documented significant hydrologic connections between a bittern pond (Pond 13, Newark) and the traditionally navigable waterbody San Francisco Bay, due to past cracks, holes, and subsurface seepage of bittern into adjacent tidal marshes and sloughs, affecting water quality (RWQCB 1985).
- Ver Planck (1958) concluded that significant leakage occurs generally in concentrator ponds (the original condition of pond 13); the theoretical 10:1 ratio of concentrator to crystallizer pond area is in practice 15:1 because of pond leakage and rainfall inputs (Ver Planck 1958)
- Leslie Salt conceded at least one instance of direct tidal overtopping of a bittern pond levee (hydrologic input of tidal water) and backflow of "diluted" bittern to tidal waters of the Bay in December 1982 (Washburn 1985b), and other instances should be expected based on the authorized levee repair cycle. A similar phenomenon of bittern pond surface brine spillage the Bay was again reported by the RWQCB in the last decade (Rogers 2007).

Thus, the salt ponds at Redwood City not only have "significant nexus" to the traditionally navigable waterbody of San Francisco Bay in modern times, the Corps in fact "traditionally" asserted jurisdiction over the minor, nameless tributary sloughs and "banks" (salt marsh) of the tidelands of Westpoint Slough (the site of modern Redwood City salt ponds) as portions of the traditionally navigable waterbody itself.

5.0 Conclusions

The geographic extent of CWA Section 404 jurisdiction in all salt ponds is established first by their commerce clause nexus as waters that have been used, and are susceptible to use, for commercial crude salt production in interstate commerce. Additional Section 404 commerce clause nexus is established by their past use and susceptibility to Refuge-type use (recreation, wildlife viewing), variable degrees of migratory bird or endangered species use, and actual or potential brine shrimp harvest. Brine shrimp harvest (past or potential/"susceptible" use) also establishes and expands RHA 10 jurisdiction from diked unfilled slough beds to the entire surface of the impounded historic tidal marshland and creek system of the salt pond bed. At a minimum, RHA 10 jurisdiction extends inextinguishably over all dammed (diked) tidal slough beds below the original relative position of Mean High Water, even if brine shrimp boat transport is not considered in Section 10 RHA determination.

Hypersalinity or specific ion composition of salt pond brines, like the artificial nature of industrial salt ponds, is no barrier to CWA Section 404 jurisdiction. There is no regulatory basis for establishing salinity or brine composition thresholds for CWA Section 404 jurisdiction, and their arbitrary assertion would inevitably cause capricious and unpredictable, meaningless changes in jurisdictional status at best. At worst, an arbitrary salinity or compositional threshold for "waters of the U.S." would provide an arbitrary means of eliminating jurisdiction and circumventing regulation, contrary to the purpose of the CWA – rewarding rather than regulating degradation of water quality. The Corps San Francisco District has a long history of broad assertion of its Rivers and Harbors act authority over diking and filling tidal marshes and small tidal creeks and ditches, even before the era of environmental quality regulation.

Key factual determinations for analysis of contemporary Corps jurisdiction under the Clean Water Act and Rivers and Harbors Act include:

- Prior to the Clean Water Act, the Corps in fact "traditionally" asserted Rivers and Harbors Act (traditional navigable waters) jurisdiction over the minor, nameless tributary sloughs and "banks" (salt marsh) of the tidelands of Westpoint Slough (the site of modern Redwood City salt ponds) as portions of the traditionally navigable waterbody itself. (Sections 3.0 and 4.0)

- The brines that currently occupy the permanently flooded ponds, and the pond beds themselves, are impoundments San Francisco Bay tidal waters. These impoundments have merely been artificially managed to maximize evaporation, brine concentration, salt saturation, and salt crystallization, like natural salt-producing salt pans and salt ponds (Ver Planck 1958), but they are fundamentally jurisdictional impoundments of San Francisco Bay that were permitted by the Corps San Francisco District prior to the Clean Water Act.

- The original, existing dikes (levees) that impound concentrated San Francisco Bay waters at the Redwood City salt ponds along Westpoint Slough were authorized by the revocable Department of the Army (DA) permit under the authority of the Rivers and Harbors Act, issued to Stauffer Chemical Company in 1940.

- The tidal channel beds within the diked marsh plain that forms the bed of the salt ponds were regulated as (and remain under current regulation and guidance) lateral extensions of the traditionally navigable waterbody, San Francisco Bay.

- But for the (revocable) historic federal Department of Army permit to construct dikes and slough dams along Westpoint Slough, the beds and banks of the salt ponds would be continuous with those of the adjacent traditionally navigable waterbody, San Francisco Bay.

- The surface waters of San Francisco Bay would ebb and flow over the diked sloughs, banks and marsh plains but for the (revocable) historic federal Department of Army permits to construct dams across sloughs and dikes on the banks of slough.

- The salt ponds at Redwood City have "significant nexus" to the traditionally navigable waterbody of San Francisco Bay in modern times because all solutes (salts) of direct commercial and indirect biological values of national importance (including its designation to be included in a National Wildlife Refuge) are derived exclusively through impoundment of navigable San Francisco Bay waters. (Sections 1.0, 4.0)

- Rivers and Harbors Act jurisdiction is not extinguished by Department of Army permits or sudden artificial changes, and the San Francisco District has asserted Section 10 jurisdiction at least over unfilled tidal sloughs (below the plane of former mean high water) behind dikes.

- The bittern pond is a former concentrator pond that was long used for industrial purposes in interstate commerce (salt production) (Ver Planck 1958; 1953 map of SF Bay Pond system) (Section 1.0)

- Bittern brines produced in the South Bay solar salt industry were themselves were sold in interstate commerce, (Ver Planck 1958)and are susceptible to use for interstate commerce. (Section 1.0)

- Salt ponds are also susceptible for use, and have been used for commercial harvest and transport of brine shrimp sold in interstate commerce, under lease agreement from the Refuge (USFWS 1992) (Section 1.0)

- Salt pond types such as concentrator, bittern, and pickle ponds are interconvertible at the discretion of the operator (Van de Kamp 1986). Pond 13 is a former concentrator pond converted to bittern storage use after commercial sale of bittern was discontinued. (Sections 1.0, 4.0)

- The Corps has established consistent precedents of asserting Section 10 RHA and Section 404 jurisdiction over salt ponds, and explicitly over salt ponds with saturated and supersaturated brines and slough traces (crystallizers at Napa; Corps Permit No. 400258N, 2007; crystallizers in South Bay, Corps Permit No. 19009S98) without exception since the 1980s.

- The Corps has in general broadly asserted "traditional" Section 10 jurisdiction (prior to 1970s precise regulatory criteria for geographic jurisdiction under Section 10) over construction of dikes on tidal slough banks (marsh banks) and dams across tidal sloughs for purposes of marsh reclamation (conversion to salt ponds and agriculture) since at least 1904.

- The Regional Water Quality Control Board (RWQCB) has documented significant hydrologic connections between bittern ponds and the traditionally navigable waterbody San Francisco Bay, due to spillage cracks, holes, and subsurface seepage of bittern into adjacent tidal marshes and sloughs, affecting water quality (Sections 1.0, 4.0).

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STATEMENT OF QUALIFICATIONS

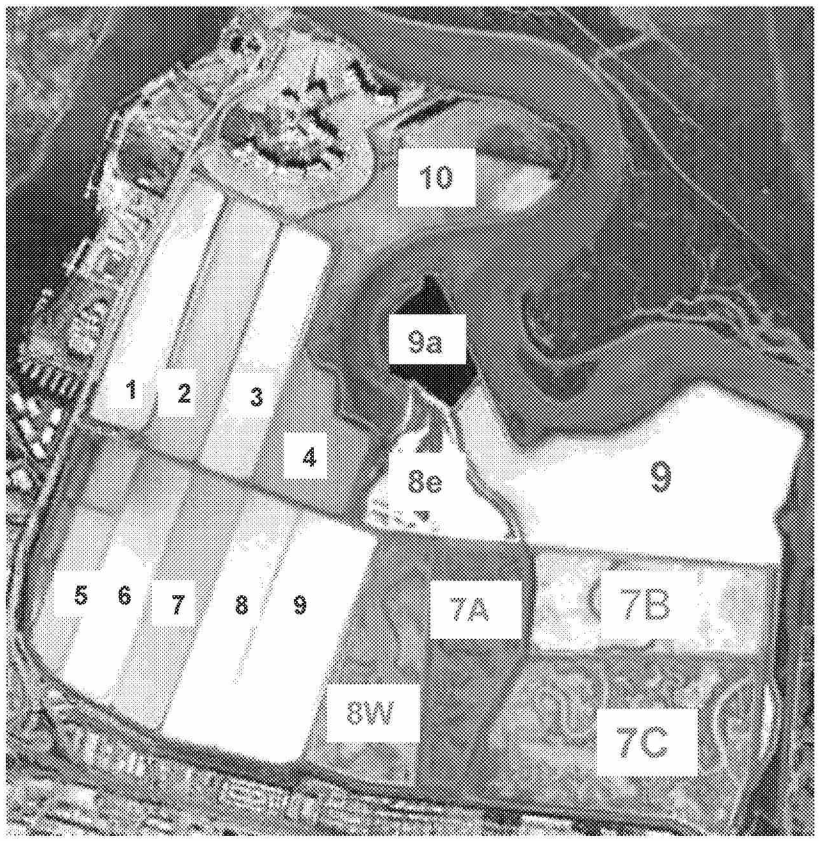
Peter Baye (Ph.D. Plant Sciences, University of Western Ontario, Canada) is a coastal ecologist and botanist with over 30 years professional experience in management, restoration, regulation, applied research, and planning of coastal wetlands, beaches, and dunes. He was a environmental analyst and regulatory project manager for the U.S. Army Corps of Engineers, San Francisco District, from 1991 to 1997, where he prepared Clean Water Act Section 404(b)(1) analyses, jurisdictional determinations, public interest evaluations, endangered species consultations, and analysis of environmental impacts, mitigation and alternatives pursuant to the National Environmental Policy Act (including joint EIS/EIR management). He was responsible for regulatory and scientific analysis of the Leslie Salt/Cargill levee and salt pond operation permit application from 1991-1994, and collaborated with the District's Office of Counsel and Department of Justice during litigation over enforcement actions and jurisdictional disputes within the scope of the Cargill permit application. He worked as staff biologist for the U.S. Fish and Wildlife Service (Sacramento Fish and Wildlife Office) Endangered Species Division from 1997-2002, where he prepared endangered species recovery plans, assisted with recovery implementation and technical support, and Endangered Species Act Section 7 consultations. During both USACE and USFWS employment, he contributed to writing the San Francisco Bay Area Wetland Habitat Goals Project. Since 2002, he was worked as an independent consulting coastal ecologist, with emphasis on conservation, restoration and management of coastal wetlands, lagoons, beaches, and dunes, and implementation of endangered species recovery actions.

FIGURES

Figure 1. Aerial photograph dated 10-5-1943, showing the baylands of Redwood City Salt Pond system area as they existed at the time. The baylands between First Slough and (artificial) Flood Slough were tidal salt marsh and creeks (area occupied by modern ponds 9, 9A, 8W, 8E, 7A, 7B, 7C). The diked area along northern Westpoint Slough occupied by modern crystallizer ponds and Pond 10 were salt evaporation ponds (concentrators) or other diked baylands, lacking the rectangular beds of crystallizers. No bittern storage ponds existed (bittern storage did not occur until the 1970s).

a

Figure 2. 2007 Cargill Redwood City salt ponds. a) aerial photograph showing salt ponds and and adjacent salt marshes and tidal sloughs



b

Figure 3. 2007 Cargill Redwood City salt ponds, showing 2002 Cargill pond numbering following WRA 2002. Ponds 9, 9a, and 8e were identified as bittern storage ponds in 2002. Ponds 7A, 7B, 7C, and 8W were identified as pickle ponds in 2002. Rectangular ponds 1-9 were identified as crystallizer ponds in 2002. Pond 10 was identified as a bittern desalting pond in 2002. The current post-industrial production types or uses of these ponds, if any, have not been determined. Bittern Pond 9 exhibited extensive emergent bed and excavated/filled mounds and ridges in winter 2010.


a

b

c

Figure 4. Recent bed modification of bittern pond 9. a. Summer 2009 aerial photo showing parallel rows of cut and fill ridges and troughs. Note the emergent "dry" beds of Pond 9 and adjacent pickle ponds (7A-C; brine in relict tidal slough channel only). b-c. Interior of Pond 9 viewed from Westpoint Slough, January 2010.

Figure 5. Pond 9 (south), hypersaline emergent mudflats and shallow flooded flats outside of excavated/filled portion, viewed from Flood Slough, January, 2010. Scattered fill mounds and pipes are present in the partially drained bittern pond flats.

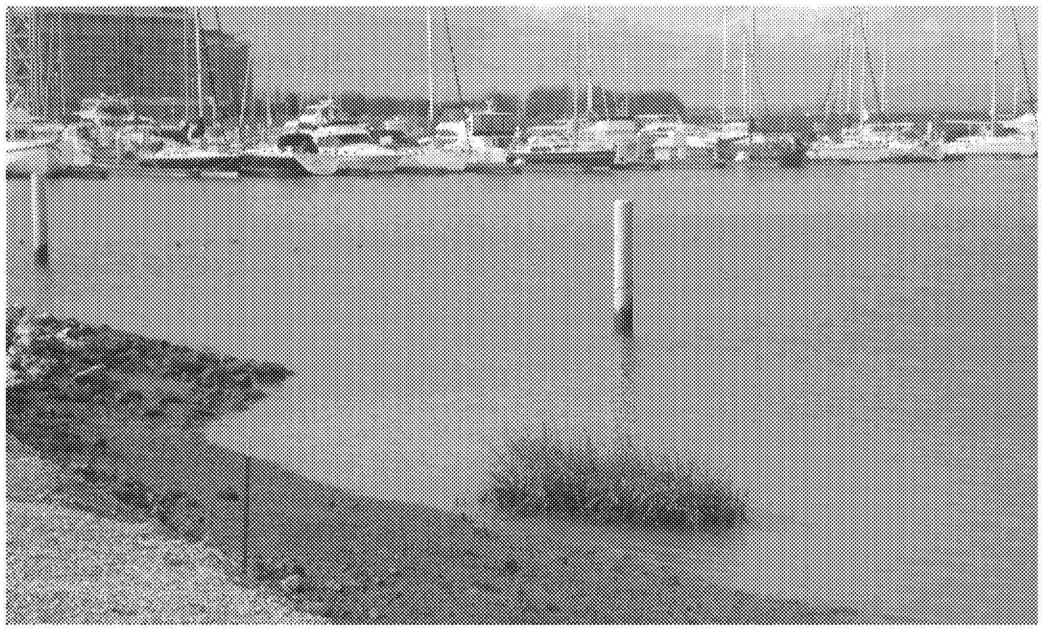


Figure 6. Recent modification of bittern desalting Pond 10. Conversion to marina in use, and under construction on east side; conversion to shallow saline lagoon and mudflats, west side. Winter 2010 photos.

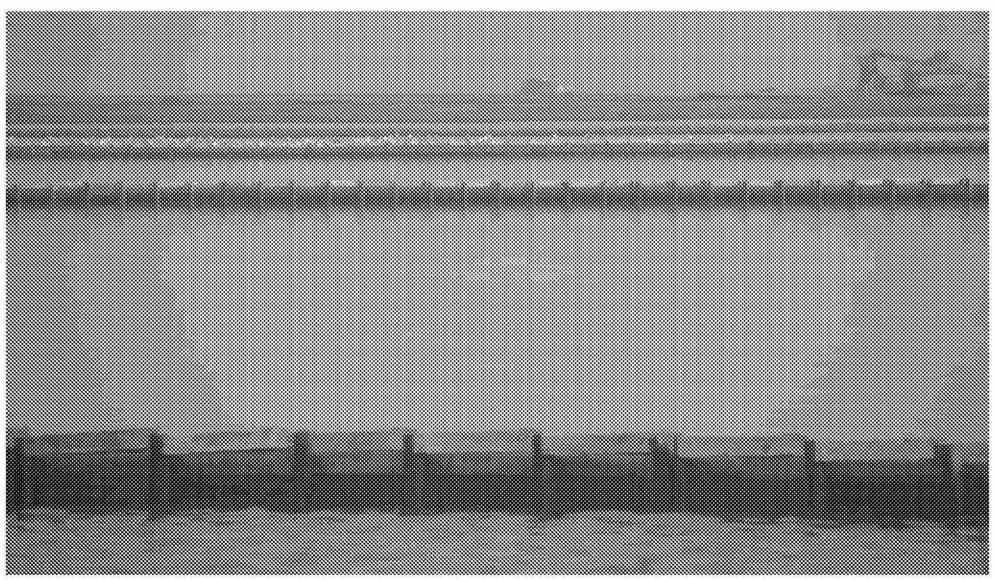


Figure 7. Ground views of crystallizer salt ponds at Redwood City, fall 2009 and winter 2010. Note flock of white waterbirds (unidentified) roosting in the crystallizer pond, top.

Figure 8. Pond 7c, viewed from Bayfront Park/Flood Slough, January 2010. Tidal marsh vegetation extents to crest of perimeter levee; Flood Slough at extreme high tide (marsh submerged), foreground; Pond 7c with internal cross-levees, background.

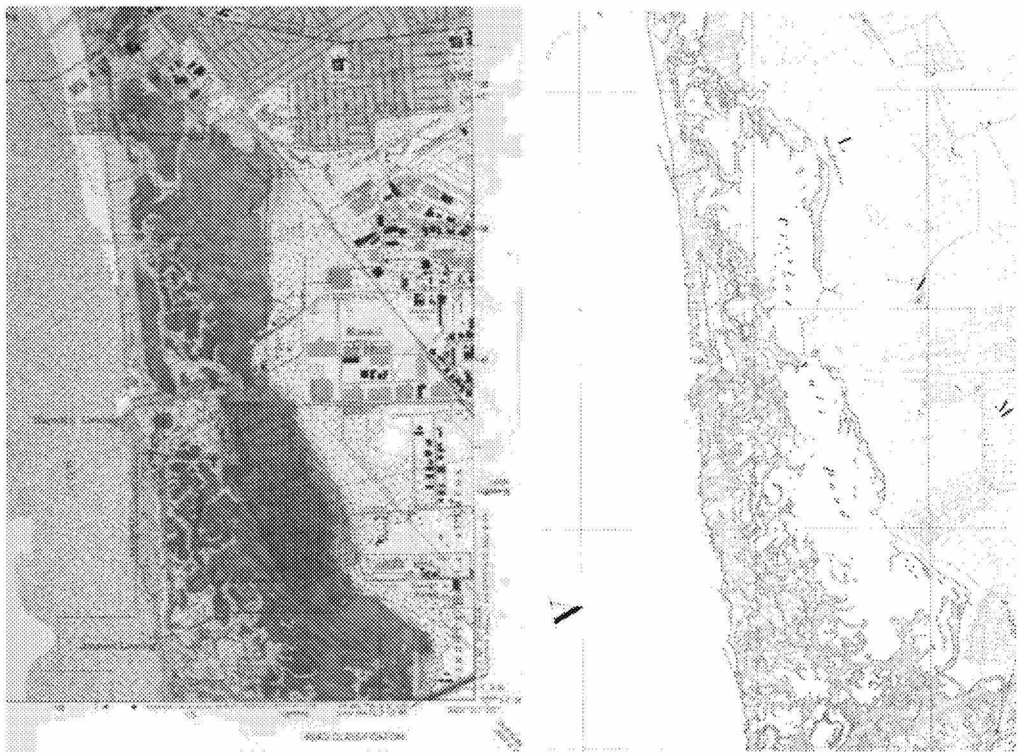


Fig. 9 Crystal Salt Pond (Hayward/San Lorenzo), the largest early historic natural salt pond in San Francisco Bay. a. overlay of salt pond on USGS quad sheet (excerpted from Grossinger and Brewster 2003). b) excerpt of Crystal Salt Pond from U.S. Coast and Geodetic Survey sheet T-635 (early to mid-1850s field mapping) .

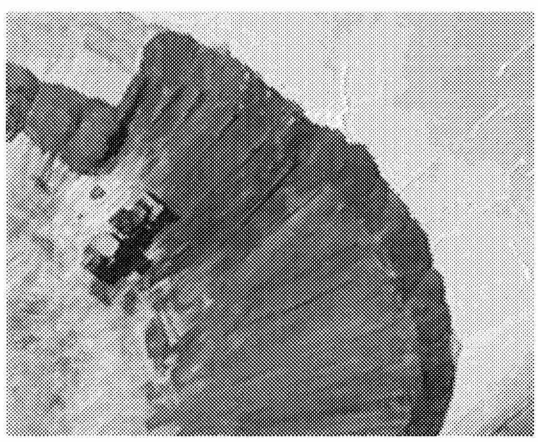


Figure 10. Pond 8e and 4 (former crystallizer pond) filling operations. Google Earth image July 2007, accessed February 2010. Note series of spoil (dewatered sediment) piles and slip-face (steep fill edge, shadow) at edge of spread by ground-based (scraper) equipment in Pond 4. Note regular, structured fill pad pattern and topographic relief (shadow of steep slip-face at edge of fill) of fill in Pond 8e. Google Earth image July 2007, accessed February 2010.

EXHIBIT 2

11-30-95

DEPARTMENT OF THE ARMY PERMIT

Permittee: Cargill Salt Division

Permit No. 19009S98

Issuing Office: Department of the Army
San Francisco District
211 Main Street
San Francisco, California 94105-1905

The District Engineer, U.S. Army Corps of Engineers (Corps), San Francisco District, hereby issues a Department of the Army permit for certain structures and work occurring in or affecting navigable waters of the United States and the discharge of dredged or fill material into waters of the United States, pursuant to Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403) and Section 404 of the Clean Water Act (33 U.S.C. 1344).

NOTE: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the Corps of Engineers, San Francisco District.

Project Purpose: To sustain operation and production of the solar salt facilities in the south San Francisco Bay.

Project Location: Activities described below will occur in San Francisco Bay and various sloughs and creeks in the cities of Hayward, Union City, Fremont, Newark, San Jose, Sunnyvale, Mountain View and Redwood City, in Alameda, Santa Clara and San Mateo Counties respectively, California.

You are authorized to perform work in accordance with the terms and conditions specified below.

Project Description: Activities including operation, repair, and new construction associated with the production of solar salt in the southern portion of San Francisco Bay.

The following activities would be covered under this permit.

1. Repair, replacement and servicing of existing facilities[1]. These will not require Corps of Engineers specific approval as described in 2., below.

    a) Repair and replacement of existing bay intake structures, brine control structures, and related facilities such as pumps, gates, pipelines, siphons, open channels and culverts. Removal of silt and algae. Excavated material shall be placed in an identified upland area unless specified otherwise in the advanced notification.

    b) Excavating, clearing and retrenching of existing intake structures and brine conveying ditches so long as the existing configuration is not altered substantially. Excavated material shall be disposed onto levee tops above the plane of the high tide, or hauled off-site to a non-jurisdictional area.

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[1]. Some of the repair and replacement activities could be authorized by nationwide permit #3. For the sake of expediency and permit streamlining, they are also included here, since this permit is valid for 10 years.

c) Repair and replacement of existing bridges, bridge foundations and abutments within the network of salt pond levees.

d) Repair and replacement of other items such as existing fences, tide gates, siphons in non-tidal areas, powerlines, etc., provided such repair and maintenance does not deviate from the plans of the original facility.

e) Repair of existing authorized reaches of riprap. The authorized riprap areas are designed to have approximately 4:1 slope. If additional work would exceed the existing reach by 10 linear feet, then the proposed design should be submitted in accordance with the procedures for new work in the riprap section 2 h) below.

f) Spot repairs and rehabilitation of crystallizer beds. This work will be accomplished with land based equipment.

2. Ongoing and new work:

The following activities require site specific review and approval by the Corps of Engineers in consultation with the U.S. Fish and Wildlife Service (USFWS), the U.S. Environmental Protection Agency (USEPA), the California Department of Fish and Game (CDFG), the San Francisco Bay Conservation and Development Commission (BCDC), and the San Francisco Bay Regional Water Quality Control Board (RWQCB), (all collectively referred to as "the Agencies"), pursuant to the notification procedure described in special condition 3, and in accordance with the Best Management Practices (BMPs) referenced in special condition 1 below.

a) Placement of dredged and fill material on the pond side of salt pond levees including replacement of the eroded beach below the plane of high water in the pond for the purpose of raising and fortifying the levees to prevent degradation (see Sheet 8). The material, either dredged mud from the salt pond or imported fill, will be placed along the inside and the top of the salt pond levee in accordance with the BMPs. Alternatively, where possible, slough mud from outside the ponds may be used if the dredge has sufficient reach.

b) Dredging of existing and new borrow ditches within the salt ponds for the purpose of placing the dredged material on existing levees. This will be performed most commonly by a floating clamshell dredge referred to as the Mallard, but also may be accomplished using a dragline or barge mounted dredge. A generalized cross section of a typical salt pond and levee system to be dredged is represented on Sheet 8.

c) Dredging in salt ponds to allow the floating dredge to cross a pond, with the placement of dredged material on the pond bottom along the side of the dredged channel.

d) Dredging of and placement of dredged material at 38 existing dredge locks, and at any newly constructed authorized dredge locks, to allow the Mallard to access the salt ponds. Advanced notification for these activities shall include specific quantities of material to be dredged and placed, and drawings indicating prestaked, designated areas for stockpiling, sidecasting and borrowing material. The use of dredged locks shall be specifically approved case by case, and follow the BMPs. This work includes:

i dredging an access channel about 40 to 50 feet wide and up to approximately 350 feet long through salt marsh vegetation or mud flats from a slough to a lock levee and breaching the levee;

ii if the access channel is greater than 60 feet in length, temporarily sidecasting dredged material onto a preapproved area adjacent to the access cut;

iii if the access channel is less than 70 feet, temporarily storing dredged material on the lock or salt pond levee, or designated (pre-approved) stockpile area. If between 60 and 70 feet, the material may be placed in either area;

iv breaching approximately 200 to 400 cubic yards of the dredge lock levee for dredge entry into the lock basin and placing the breached material in a designated stockpile area, and moving dry stockpiled material from past lock entries into the breached area to dam the lock;

v dredging up to approximately 2,000 cubic yards of accumulated sediment within the basin of the lock and placing the material on the inside and top of the lock levee, on adjacent salt pond levee, or into the adjacent salt pond;

vi breaching approximately 400 to 1000 cubic yards from the main salt pond levee for the dredge to enter the salt pond. Breached levee material, stockpiled from the last time the lock was accessed atop the main levee will be used to dam the breach following entry.

vii upon dredge exit, breaching and plugging levees in a similar fashion to that described above. The salt marsh muds that were excavated and sidecast in the access cut will be retrieved and placed back into to the access cut and channel, closing it behind the dredge.

viii upon dredge exit, inserting a small culvert in to the lock at an elevation that will allow appropriate circulation of high tides into the lock basin to prevent the accumulation of undesired sediments.

e) Dredging within shallow sloughs to provide up to four feet of clearance for access by the Mallard. Examples include Mowry Slough to allow the floating dredge access to dredge locks Plant 2, ponds 6 and 7, within Albrae Slough to access Plant 2 locks 3 and 4, within Ravenswood Slough to access lock RCW 3, and within Charleston Slough to access lock A1. Dredged material that cannot be placed on salt pond levees may be placed on bare mud flats following approval in accordance with the notification procedure. Some slough dredging may also be performed near dredge locks for the purpose of obtaining additional mud to bring the access cut fills to the desired elevation following exit by the Mallard (see Attachment A, 5).

f) Installation of new intake and brine control structures, new pumps, siphons, culverts, power transmission lines channels/ditches, crossings of channels and streams, in conjunction with new work, or relocation of existing structures.

g) Construction of new pumping donuts, internal coffer dams, and internal salt pond levees.

h) Placement of new riprap made up mostly of small pieces of demolition rubble (broken concrete slabs) along outboard and inboard levees as needed to fortify the slopes and prevent erosion, *so long as the permittee has adequately demonstrated that the proposed new riprap is the least damaging, practicable alternative available to prevent levee erosion.* Riprap will be placed below the high tide line and/or high pond level at a slope of about 4:1 where needed, as illustrated on Sheet 9, taking care to minimize the number of voids between the rubble that might be utilized by red foxes. Riprap placed on top of non-eroding salt marsh is not authorized.

i) Repair and replacement of siphons that cross salt marsh, sloughs and channels that would require extensive trenching and sidecasting mud.

j) Dredging and placement of bay muds into eroded areas along selected outboard levees with the purpose of encouraging the establishment and expansion of salt marsh vegetation to diffuse wave energy and prevent levee erosion. The quantities of dredged material to be moved will vary greatly depending on site specific conditions and will be included in the notification procedures. The desired height of the constructed mounds will approximate the high tide elevation (see Sheet 13).

k) Dredging a "sump" approximately 75 feet by 75 feet by 2 1/2 feet deep, in the mud flat of a slough in the immediate vicinity of a staked access cut to a dredge lock, placing the dredged mud on an adjacent levee (within reach of the Mallard). The "sump" will serve as a receptacle for excess dredged material from cutting the access channel. This authorization is for Best Management Practice 3, described in Attachment A.

Permit Conditions:

A. General Conditions:

1. The time limit for completing the work authorized ends on <u>July 31, 2005</u>. If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.

2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.

3. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and state coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

4. If you sell the property associated with this permit, you must obtain the signature of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. If a conditioned water quality certification has been issued for your project, you must comply with the conditions specified in the certification as special conditions to this permit. For your convenience, a copy of the certification is attached if it contains such conditions.

6. You must allow representatives from this office to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of your permit.

B. Special Conditions:

1. The permittee shall perform all of the activities described above in accordance with the Best Management Practices (BMPs) described in Attachment A. Any specific exceptions to these

EXHIBIT 3

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES

SALT IN CALIFORNIA

BULLETIN 175
1957

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

CHAPTER 2

METHODS OF RECOVERY

CONTENTS OF CHAPTER 2

Illustrations

METHODS OF RECOVERY

SALT FROM SEA WATER

Solar evaporation is the only method now used for producing salt from sea water on a commercial scale, and even this is feasible in only a relatively small number of localities. Primarily, there must be sufficient evaporation and space available to produce a crop of salt large enough to handle economically. Of equal importance is the proximity of large industrial consumers that depend on low-cost salt with minimum freight charges. The California salt industry and the Pacific Coast chlorine-caustic industry in particular are mutually interdependent. Neither without the other could have achieved its present state of development.

California Practice. As primitive man knew, the production of salt by the evaporation of sea water is a simple operation. The commercial production of pure salt free from calcium and magnesium salts, however, requires a considerable degree of skill. Crude sea salt produced in California today contains at least 99 percent sodium chloride.

The process is essentially fractional crystallization. Sea water passes first through a series of outer or concentrating ponds where it is brought to saturation with respect to sodium chloride, and the less soluble salts are precipitated. The final concentrating pond is called the pickle or "lime" pond, and saturated brine is called pickle. To this point evaporation has reduced the volume of pickle to about 10 percent of the volume of sea water taken in. Next, pickle is run into a separate group of ponds called crystallizing ponds where continuing evaporation causes salt to form. In order to avoid the precipitation of the very soluble magnesium salts, the concentration of the liquor in the ponds is kept at a specific gravity of 29° to 30° Be by withdrawing mother liquor or bittern and replacing it with fresh pickle. The bittern may or may not be sold to chemical plants for the recovery of additional chemicals.

It will be recalled from the discussion of the precipitation of sea salts in an earlier section of this report that there is an overlapping of the crystallizing ranges of gypsum, salt, and the bittern salts. Some gypsum continues to crystallize in the range of maximum salt crystallization, and similarly the first traces of the bittern salts come down with the sodium chloride. Therefore the precipitation of neither gypsum nor bittern salts in the crystallizing ponds can be entirely prevented.

Concentrating ponds have natural mud bottoms and are formed by levees built of nearly impervious mud. Pond bottoms must be naturally water tight because no economical way of sealing leaking ponds is known. As far as possible concentrating ponds are located between the high and low tide marks so that the intake can be by means of tidal gates to minimize pumping. As the brine becomes more concentrated through evaporation it is pumped from one pond to the next. Individual ponds are shallow to allow maximum evaporation and 100 to 500 acres or even larger in size.

Typically the concentrating ponds are arranged in a series of about 10. Almost always terrain features make it necessary to divide the concentrating area into small units, but there is believed to be a fundamental reason also. It has been calculated that in a single pond of area equivalent to that of a series of smaller ponds it would take about 20 years for the brine to reach saturation. One reason is that the evaporation rate decreases with increasing concentration and at saturation is only 40 percent of that of distilled water.

Crystallizing ponds are rectangular in shape and have flat bottoms prepared by scraping and rolling. Pumps and ditches are provided for rapid filling and draining. The ratio of concentrating ponds to crystallizing ponds ranges from 15 to 1 to the theoretical minimum of 10 to 1. In size they range from 10 acres or less to 50 or 60 acres, depending on the type of harvesting equipment used.

Evaporation takes place only during the spring, summer, and fall. During the winter the concentrating ponds remain full, and at some plants the crystallizing ponds are left full also. Rain water tends to lie on the surface of strong brine and does not mix with it unless the wind is strong.

Crystallizing ponds are harvested once a year and are drained one at a time shortly before the harvesting equipment is ready to enter it. All California plants

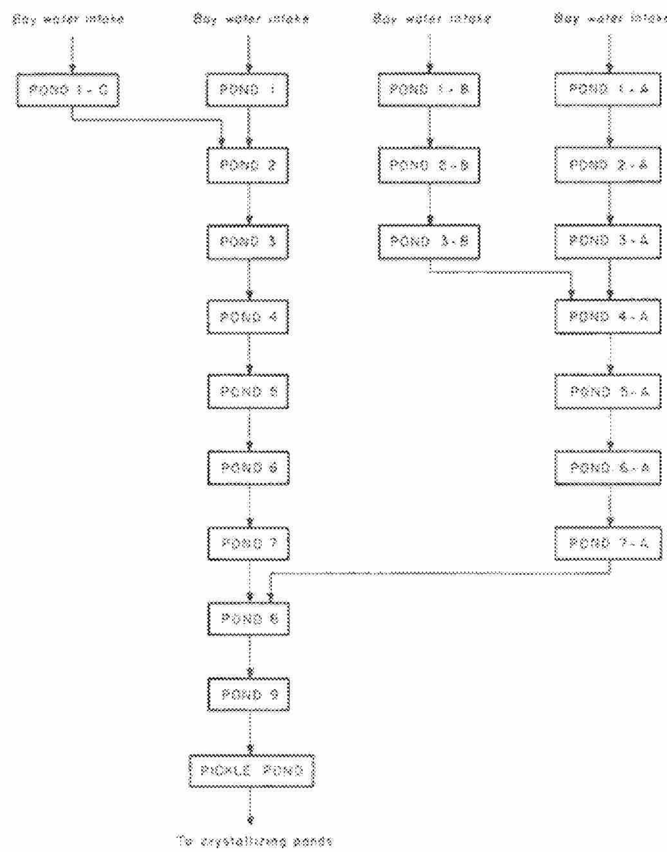


FIGURE 1. Diagram illustrating a complex series of concentrating ponds.

today use mechanized equipment that makes feasible ponds of comparatively large size.

Immediately after harvesting, the salt receives one or more washes with saturated brine followed by a fresh water spray. The salt is stacked in the open without protection.

Most of the salt is marketed as undried crude salt taken directly from the stack without further processing or ground and screened into several sizes. Undried crude salt contains 99.4 percent NaCl. Some salt is rewashed and kiln-dried and some is vacuum refined. The refined vacuum salt contains over 99.9 percent NaCl.

Prerequisites. The commercial production of salt from sea water by solar evaporation depends on three principal factors: the presence of markets, a large area of suitable land, and a dry climate with little rain for at least the greater part of the year. The marketing of salt is discussed in another section of this report.

Suitable land is limited and highly valued. With a maximum yield in the San Francisco Bay area of 40 tons per acre, thousands of acres must be in production. Small salt works of only 100 to 150 acres are in operation today, but to obtain the maximum advantage from mechanized equipment, a single salt works should contain a minimum of 5000 acres. The land ideally should be absolutely level and at or close to sea level. Above all, it should be impervious to prevent leakage of brine. Salt marshes most nearly fulfill these conditions.

For many years salt marshes were considered to be waste land of little value except for salt making, but this is no longer true. Today the salt industry must compete for it with expanding industries and communities. Portions of the marshes must be left open for various public needs such as flood outlets, navigable channels, roads, or utility easements. It is becoming increasingly feasible to reclaim marsh land by draining and filling, and large areas of former marsh land are now covered with houses or industrial plants. The solar salt industry at Long Beach passed out of existence in 1946 when the last available marsh land was filled in and used for other purposes. Elsewhere on the California coast marsh land that could at one time have been used for salt production has been filled in. In San Francisco Bay, marsh land had an assessed value of $150 per acre, a figure reported to be 40 percent of its actual value (Leslie Salt Co., 1953, p. 5).

Net evaporation must be high, and both rainfall and relative humidity must be low during the salt making season. In San Francisco the net evaporation is 34 to 49 inches per year, and an important contributing factor are the strong prevailing northwesterly winds that blow during the summer.

California Plants. The south end of San Francisco Bay most nearly combines all these factors and produces a high proportion of the solar salt manufactured in the United States. The largest producer is the Leslie Salt Co. with plant headquarters in Newark and nearly 30,000 acres of salt land in production in Alameda, Santa Clara, and San Mateo Counties. An additional area is under development on the north shore of San Pablo Bay. This company manufactures practically all grades of salt, including crude, kiln-dried, and vacuum refined. Two other small plants that produce crude salt only belong to the American Salt Company and to Oliver Brothers Salt Company. Both are near Mount Eden. The Morton Salt Company has a plant at Newark in which salt is refined, but that company does not produce crude salt in California.

In addition to the plants on San Francisco Bay, three others on the California coast produce salt from sea water. The Western Salt Company has a medium-sized salt works near Chula Vista on San Diego Bay and a second smaller operation at the head of Newport Bay, Orange County. The third is the Monterey Bay Salt Works at Moss Landing, operated by E. C. Vierra.

In the following pages the production of crude salt from sea water by the California plants is described. Salt refining is discussed in another section of this report.

Operations of the Leslie Salt Co.*

The Leslie Salt Co. (Buchen, 1937; Schrier, 1952) is the largest producer of salt in California and one of the leading producers of salt from sea water by solar evaporation in the entire world. The main office is at 505 Beach Street, San Francisco; and the plant office and principal facilities are on Central Avenue, Newark. Fred B. Bain is President, J. C. Buchen is Vice President and Production Manager, and Sheldon Allen is Secretary and Treasurer. The Company owns 44,000 acres of land on the Bay shore of Alameda, Santa Clara, and San Mateo Counties and additional property on the north shore of San Pablo Bay southwest of Napa. It owns outright the subsidiary Leslie Terminal Company and has a controlling interest in the California Salt Company at Bristol Lake, San Bernardino County.

Facilities included four crude salt producing units in production and a fifth under development at which cars and trucks are bulk-loaded, a deep water terminal for the bulk loading of ships at the Port of Redwood City, an undried crude salt processing plant at Newark, and a refinery at Newark that produces both kiln-dried and vacuum refined salt. The largest crude salt plant, Newark Number 2, lies south and west of Newark around the south end of San Francisco Bay. Another, Newark Number One, is bisected by the eastern approach to Dumbarton Bridge; a third, the Baumberg plant, lies southwest of Mount Eden; and the fourth is on the San Mateo County marshes near Redwood City. A plant under construction near Napa is scheduled for production in 1959.

The Leslie Salt Co. is a consolidation of numerous small plants, some of which had been in production since the 1860's. Corrosion and maintenance of the small plants that were constructed of inferior materials contributed to high operating costs, while lack of capital and volume of business discouraged investment in modern equipment. Most of these small plants adjoined one another so that combining their operations was practical. Consolidation started in 1924. Companies were merged, some plants were dismantled, others were relocated and modernized. The process was completed by 1941.

* Plant visits 1952.
See, D. S., The salt industry, unpublished paper presented at Nonmetallic Minerals Conference, Pacific Chemical Exposition, San Francisco, Oct. 23, 1947.

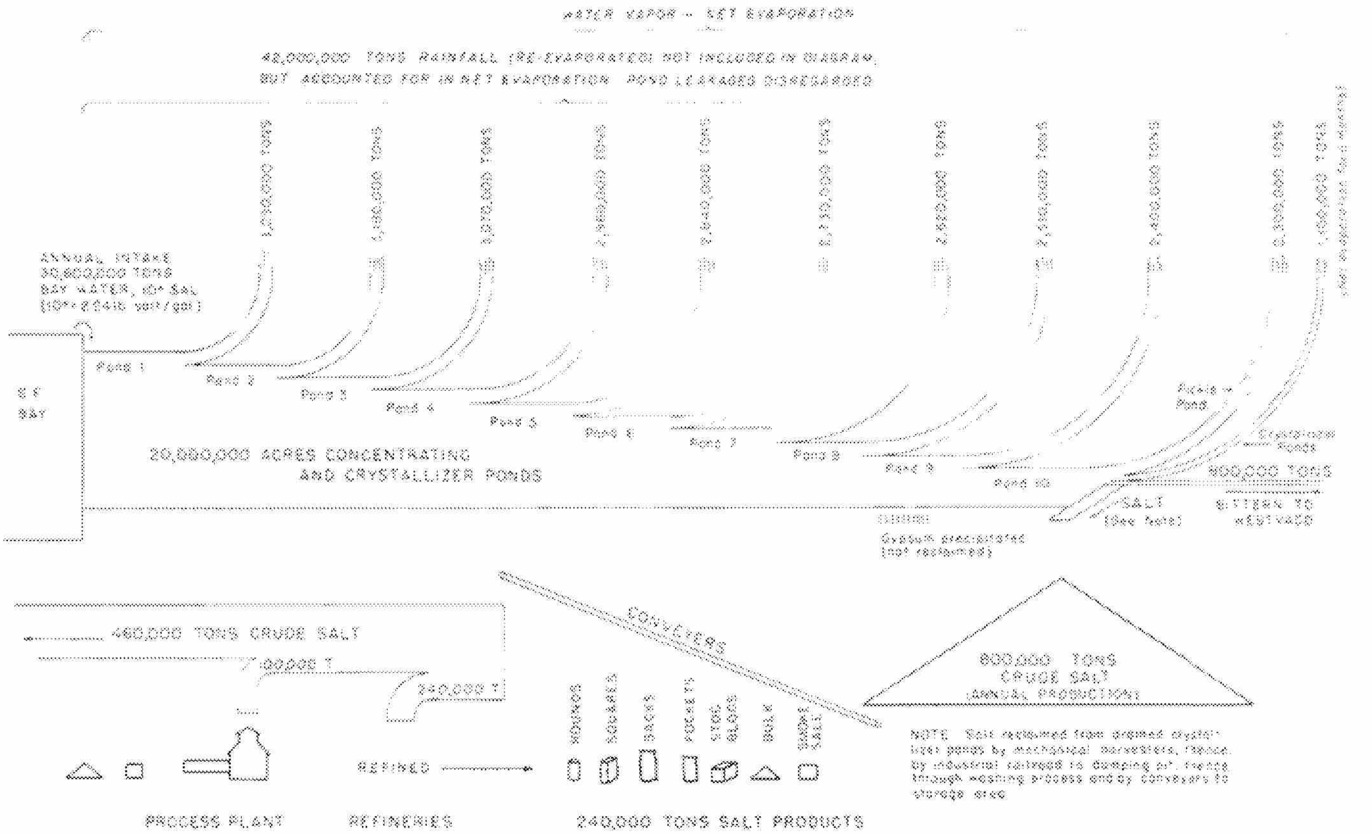


FIGURE 2. Flow chart showing production of salt from sea water.

The growth of the Leslie Salt Co. and its predecessors is startling. In 1936, the year Leslie Salt Co. was incorporated, a production of 300,000 to 325,000 tons was obtained from approximately 12,000 acres of marsh. Ten years later crops of 450,000 to 500,000 tons were harvested, and the area in production had increased to 25,000 acres. In 1952 nearly 29,000 acres yielded 706,000 tons of salt. It is expected that by 1954, 30,000 acres, all that is available in San Francisco Bay, will be in production. By 1959, when the first crop of about 100,000 tons is expected from the plant now under construction near Napa, on San Pablo Bay, production will have reached 1,000,000 tons a year.

FIGURE 3. Crystallizing ponds of the Newark No. 2 crude salt plant, Leslie Salt Co. near Newark, Alameda County. With a maximum yield of 40 tons of salt per acre in the San Francisco area, thousands of acres of marsh land are required. *Photo courtesy Leslie Salt Co.*

Evaporating Conditions. Rainfall in the southern part of San Francisco Bay is 10 to 22 inches per year, and the total evaporation, less rainfall, is 34 to 43 inches per year. The accompanying table shows the monthly mean precipitation and temperature at San Francisco.*

Mean monthly precipitation and temperature, San Francisco.

	Inches of rain	°F
January	4.7	50
February	3.7	53
March	3.1	55
April	1.5	56
May	0.7	57
June	0.2	59
July	0.0	59
August	0.0	59
September	0.3	62
October	1.0	61
November	2.4	57
December	4.4	52

* U. S. Weather Bureau, 1954, Local climatological data, San Francisco.

The net evaporation is concentrated in the seven months from April to October inclusive when low rainfall is combined with low humidity and strong, regular, northwesterly winds. Figures for a typical year are shown in the accompanying table (Phalen, 1917):

Net evaporation, typical year, San Francisco.

	Net evaporation (inches)
April	2.02
May	4.17
June	5.95
July	7.81
August	7.81
September	4.94
October	2.17

Salinity. San Francisco Bay is influenced by the Sacramento River, and its salinity is in general slightly less than that of the open sea. At South San Francisco where the water normally contains 2 grams per liter of magnesium oxide, as little as 0.8 gram per liter may be present when the Sacramento River is in flood. Fortunately for the salt industry, the influx of fresh water is at its lowest during the evaporating season. The accompanying table shows the salinity in degrees salometer (percent of saturation) of water measured at the intake of two of the Leslie plants during 1950 at approximately the first of the month.

*Salinity at Leslie Salt Co. plants, 1950.**

	Baumberg	Newark No. 2
April	9	10½
May	9	10
June	10½	11½
July	11	11
August	10½	12
September	13	12½
October	13	12
November	12	11

* Measured in degrees salometer.

The Marsh Land. The Leslie Salt Co.'s holdings include 40,000 acres of marsh land around the south end of San Francisco Bay. Of this, 10,000 acres cannot be used either because it must be left open for various public needs or because it is in small isolated tracts. The land is typical salt marsh that lies close to sea level and is flooded by spring tides. Meandering sloughs divide the area into tracts of slightly firmer and higher ground where a layer of peat and marsh grass covers soft mud that is impervious to water. The mud varies in thickness from zero at the landward edge to 40 feet at the edge of deep water; and underneath, firmer clays are to be found in most places. (Allin, 1948, p. 82).

The soft bay mud is very unstable and cannot support heavy loads. In former times when the salt plants were built on the marsh, the size of structures, particularly of the stock piles, was strictly limited. The construction of the ship-loading terminal at the Port of Redwood City was an interesting engineering problem that is discussed elsewhere in this report. Except for the Redwood City installations, the present plants are well back from the marsh. At Newark a layer of clay provides support, and piles are necessary for only the heaviest loads.

The Leslie Salt Co.'s property near Napa is former marsh land that was reclaimed for farming many years ago.

The Crude Salt Plants

Each of the four crude salt plants is complete in itself with its own concentrating ponds, crystallizing ponds, harvesting equipment, and washer. Each is normally operated independently of the others, although provision has been made for the transfer of brine between some of the plants to afford greater flexibility of operations. The maximum size of a single plant is limited principally by features such as sloughs and unavailable areas that form natural boundaries. The minimum area for maximum efficiency is a function of the maximum tonnage that one harvesting machine and its auxiliary equipment can efficiently handle during the harvesting season, roughly, 5,000 acres of concentrating and crystallizing ponds. Larger plants ideally would contain multiples of this area. The four plants now in operation depart somewhat from the ideal because of the distribution of the available area, and because their present form was determined in large measure by plants that existed before consolidation began.

Newark Number 2. Newark number 2, the largest of the crude salt plants, lies south and east of Newark. The washing plant adjoins the plant office, refinery, and undried salt processing plant on Central Avenue, Newark, in the northeast quarter of section 12, T. 5 S., R. 2 W., MD. The pond area in 1952 totaled a little over 11,000 acres, and the design capacity is 450,000 tons of crude salt a year. Built about 1929 as the Number 2 plant of the Arden Salt Company, it comprised originally only about 5,000 acres between Newark and Coyote Creek. Since then the plant has been expanded continually. Principal additions have been the ponds of the Alviso Salt Company west of Alviso and ponds constructed between Alviso and Coyote Creek to join the two detached areas.

Baumberg. The Baumberg plant consists of approximately 4,630 acres north of the Coyote Hills between Coyote Hills Slough and the eastern approach to San Mateo Bridge. The washer, which has a design capacity of 180,000 tons a year, is at Baumberg, off Arf Avenue and south of Mount Eden in section 5, T. 4 S., R. 2 W., MD. (projected). The pond area includes most of the important 19th century salt works, and portions have been in production since 1865. The plant achieved its present form when the ponds of the Oliver Salt Company, north of Alameda Creek, were integrated with those of the Leslie-California Salt Company to the south of it.

Newark Number 1. The concentrating ponds of the Newark number one plant are bisected by the eastern approach to Dumbarton Bridge and lie west of the Coyote Hills between Dumbarton Point and Coyote Hills Slough. The washing plant is on Jarvis Road, Newark, in the northeast quarter of section 3, T. 5 S., R. 2 W., MD., and the crystallizing ponds are in the angle formed by Jarvis Road and the Coyote Hills. The design capacity is 160,000 tons a year, and the plant contains approximately 4,400 acres. It was built as plant number one of the Arden Salt Company, which obtained its first crop of salt in 1919. The principal expansion of the pond area has been the inclusion of the northern group of ponds which were operated as a separate unit prior to

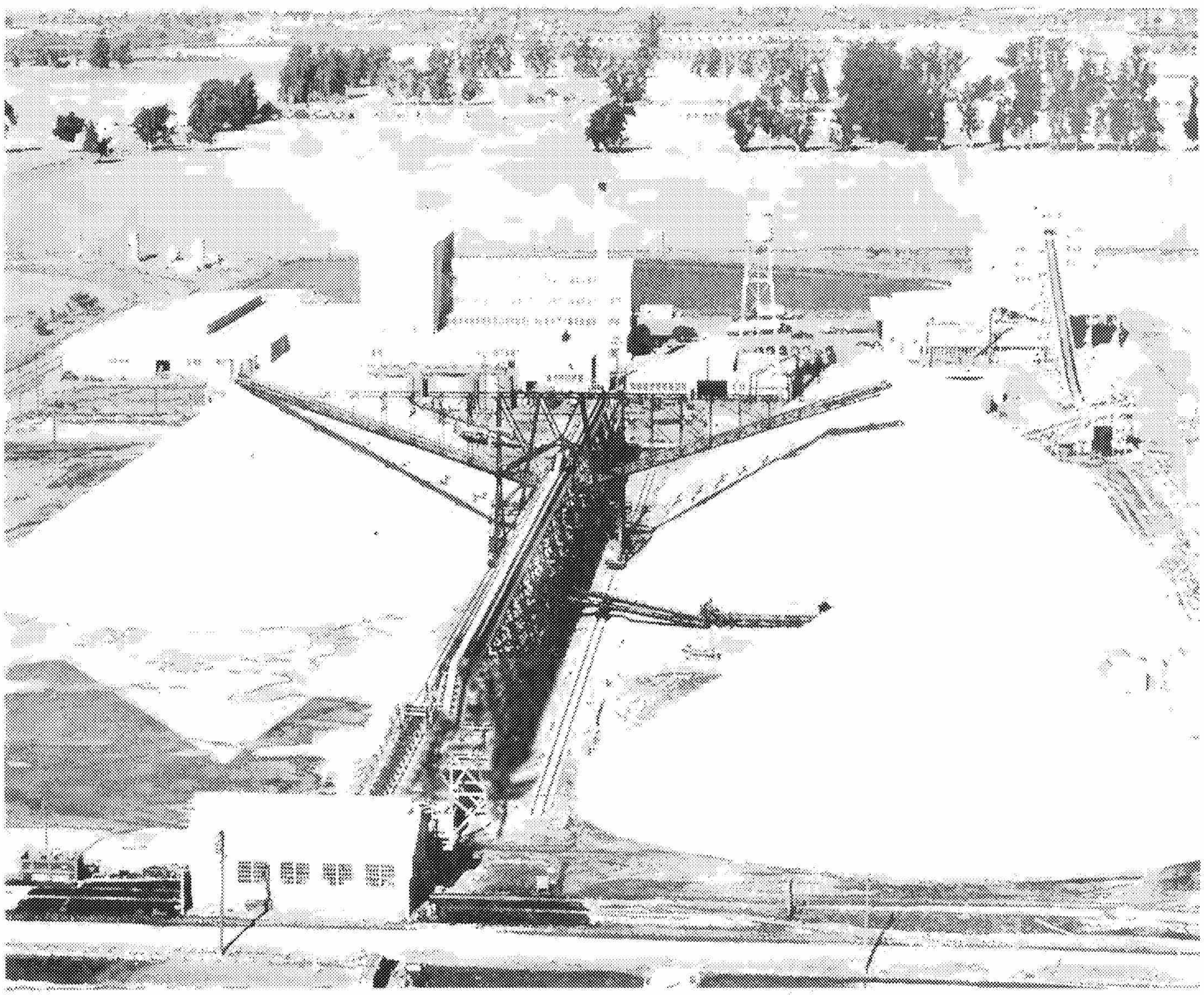


FIGURE 4. Principal plant of the Leslie Salt Co. at Newark, Alameda County. Crude salt stacks, center; washer house, foreground; evaporator house, left center; undried salt processing plant, right.
The Leslie Salt Co., the largest producer of salt in California owns 44,000 acres of land on the Bay shore of Alameda, Santa Clara, and San Mateo Counties and additional property southwest of Napa. Facilities include four crude salt plants plus a fifth under construction, ship-loading terminal, undried salt processing plant, and refinery. *Photo by Elmer Moss, courtesy Leslie Salt Co.*

1940. The present washer is the oldest in operation on San Francisco Bay. It was built in the early 1920's, to replace an earlier plant at Dumbarton Point.

Redwood City. The washer of the Redwood City plant adjoins the ship loading terminal on the west shore of Redwood Creek. The crystallizing ponds are east of the road and railroad running to the Port of Redwood City, and the concentrating ponds extend east and west on the San Mateo County marshes. When full production is reached, 250,000 tons of salt a year will be obtained from an area of approximately 7,200 acres. Salt works formerly operated in San Mateo County were closed in 1941, and the construction of the present plant began about two years later on the same site. Comparatively little of the old engineering works were incorporated into the new plant. Small harvests were obtained in 1951 and 1952, and a capacity crop was expected in 1953.

Napa. During the summer of 1953 construction began on a new plant near Napa that is expected to be in production by 1959. The property lies between Napa River and Napa Slough and extends from Buchli siding southward toward San Pablo Bay.

Concentrating Pond Systems

The evaporating ponds of the four plants now in operation are shown on the accompanying map. Concentrating ponds, in which the water is brought to saturation, are of irregular shape and from 100 acres to 500 acres or in a few cases even larger in size. Their depth is shal-

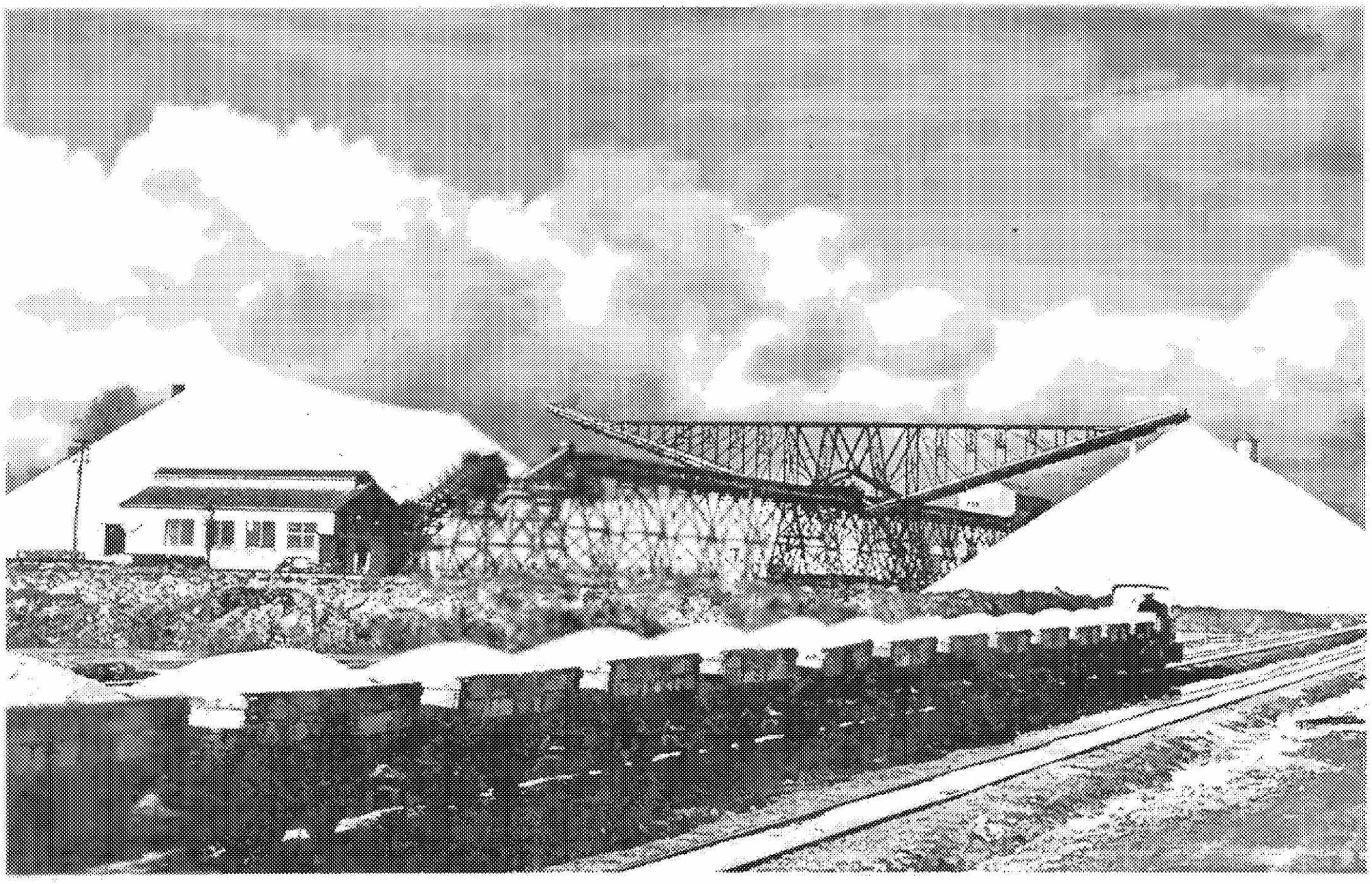


FIGURE 5. Newark No. 2 crude salt plant, Leslie Salt Co. Photo shows loaded train approaching washer house (left center), gantry stacker, and crude salt stacks. With a pond area of a little over 11,000 acres, the design capacity of the Newark No. 2 plant is 450,000 tons of crude salt per year. *Photo by Don Kragh, courtesy Leslie Salt Co.*

low to allow maximum exposure of the brine to the sun and wind. Levees are not built across sloughs if it can be avoided, and consequently the ponds occupy the areas between sloughs. Pond systems are designed so that the flow of brine from pond to pond is by gravity through control gates. Pumping cannot be entirely eliminated, and often a pump is combined with a syphon to transfer brine across a slough. Wherever possible brine is partially concentrated and its volume reduced before handling it with pumps. Gates are constructed either of iron or of creosoted wood. While the treated wood lasts longer than iron, the action of teredos makes it difficult to keep wooden gates tight. The wooden gates are being replaced with iron ones.

It will be noted that the concentrating ponds of none of the plants are arranged in the theoretical simple series of ten. Each plant has in effect several parallel series in which water taken in at a number of points is partially concentrated before joining the common path to the pickle pond. Such a system is schematically shown on the accompanying diagram. Some of these branches are ponds of formerly independent plants that have been tied into the larger system; others are new ponds that have been added to an existing plant.

The Construction of Levees. The Leslie Salt Co. is constructing new levees for its expanding operations almost continuously, and a technique has been developed, using clamshell dredges that float in their own borrow pits. Care must be taken not to break through the thin, weak surface crust of the marsh by building the levee too rapidly. If the crust is broken, it is very difficult to build the levee up to the required elevation. Erosion and slow settlement require periodic maintenance.

Outside levees are 40 feet wide at the base, 12 feet wide at the top, and $3\frac{1}{2}$ feet high. To prevent leakage between the base of the levee and the old surface, the levee is keyed to solid material by coring. In coring, a trench is dug through the grass and peat along the center line of the levee and filled with clean mud. Cross levees, or levees that separate one pond from another, may be slightly lower and usually are not cored.

Levees are constructed in stages. The borrow pit of a finished levee averages 50 to 55 feet wide and 5 to 6 feet deep, or 10 cubic yards per linear foot. This compares with the design section of 3.37 cubic yards per foot of the finished levee and reveals the extent of shrinkage and settling that takes place.

On the first pass the dredge places 60 percent of the material that will be required, and the levee is built to a maximum height of three feet. The borrow pit is dug 38 feet wide by $4\frac{1}{2}$ feet deep, just large enough to accommodate the dredge which draws four feet when listing.

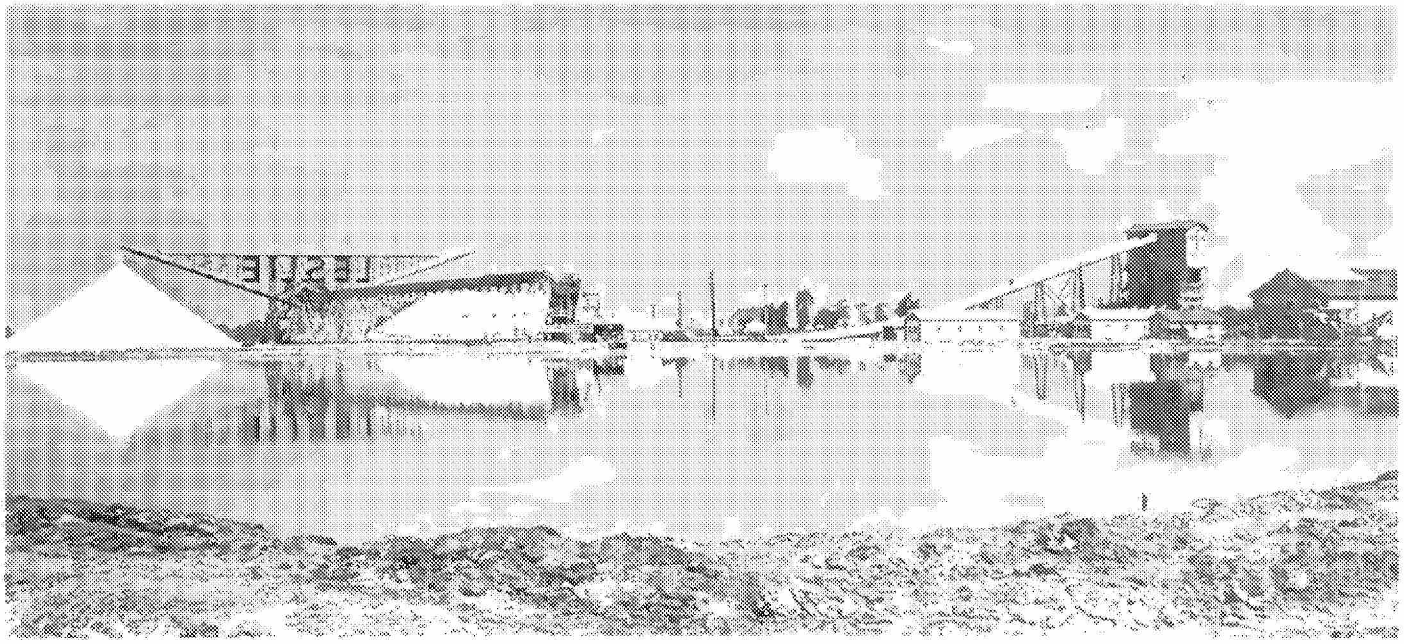


FIGURE 6. Baumberg crude salt plant, Leslie Salt Co., south of Mount Eden. The pond area of the Baumberg plant, which includes most of the important 19th-century salt works, is 4,620 acres. The washer (center) has a design capacity of 150,000 tons a year. Bulk shipments only are made from the bunker (right). *Photo by Elmer Moss, courtesy Leslie Salt Co.*

An extra 6 inches is allowed because the water level averages that distance below the surface of the marsh. After drying for 6 to 18 months the levee will have settled to a height of only 2 feet in places.

On the second pass 20 percent of the material is placed, raising the levee initially 1½ to 2 feet. After consolidation the final height may be 3 feet. The borrow pit is widened in the direction away from the levee.

The final 20 percent of the material is placed on the third pass, raising the levee initially to 4½ feet. After drying the height has shrunk to 3½ feet. The borrow pit is deepened on the side away from the levee. Thus the possibility of the levee's failing is reduced, and clean mud free from vegetation or peat is available for topping.

If a slough must be crossed, it may be necessary to drive sheet piling to retain the levee. Sections that are exposed to erosion are reinforced.

In the operation of the dredge, one swing of the bucket across the borrow pit is called a "fleet." Nine to twelve 2-cubic-yard buckets full comprise a fleet, which equals a 4-foot advance. Usually the dredge is set ahead after completing each fleet, but two or three fleets can be dredged from one position. Fifteen minutes are required to complete a fleet. Time is lost in coring, setting ahead, damming small sloughs, and in moving to new locations, so that the average rate of advance is 10 feet per hour on the first pass.

Even after the levees are completed and a pond is flooded, production cannot begin at once. Impervious though the bay mud is, seepage takes place until the bottoms have been sealed by the slow precipitation of calcium carbonate and gypsum. This sealing process is complete only after 5 to 7 years.

The Concentration Process. Bay water is taken in through automatic gates that open at high tide and close when the tide drops below the pond level. Where possible the gates are placed in north or northwesterly facing levees to take advantage of the prevailing wind. The intake at some points is by means of pumps.

During the evaporating season brine is passed slowly through the system of concentrating ponds as evaporation in the pond ahead requires replacement. The flow is controlled by gates and pumps that are reached by roads built on the levees. Every pond is examined once a week, and both the salinity and the depth of the brine are recorded.

It has been pointed out that as the result of growth and physical limitations, the concentrating ponds are arranged in rather complex, branching systems. The progress of the brine concentration may be illustrated, however, by the simple series of eight ponds followed by a pickle pond shown in the accompanying diagram. In the first stage, ponds one through six, evaporation has raised the concentration of the brine to a specific gravity of 12.9° Be and reduced the volume to nearly half of that taken in. Suspended matter settles, carbonates precipitate, and the precipitation of gypsum begins. In the second stage, ponds seven through nine, evaporation continues until, at 25.6° Be, the brine is saturated with respect to salt. By the time the specific gravity has reached 25.0° Be, most of the gypsum has precipitated. Some salt precipitates also at 25.0° Be, but any that forms in the pickle pond is dissolved when the concentration is reduced by the next filling with weaker brine. By the time the brine is ready to leave the pickle pond, its volume has been reduced by evaporation to about ten percent of the volume of bay water taken in.

The accompanying sketch portrays the vast quantity of water that must be evaporated. In order to produce 800,000 tons of salt, 30,600,000 tons of bay water containing 0.22 pounds of salt per gallon (10° salometer)

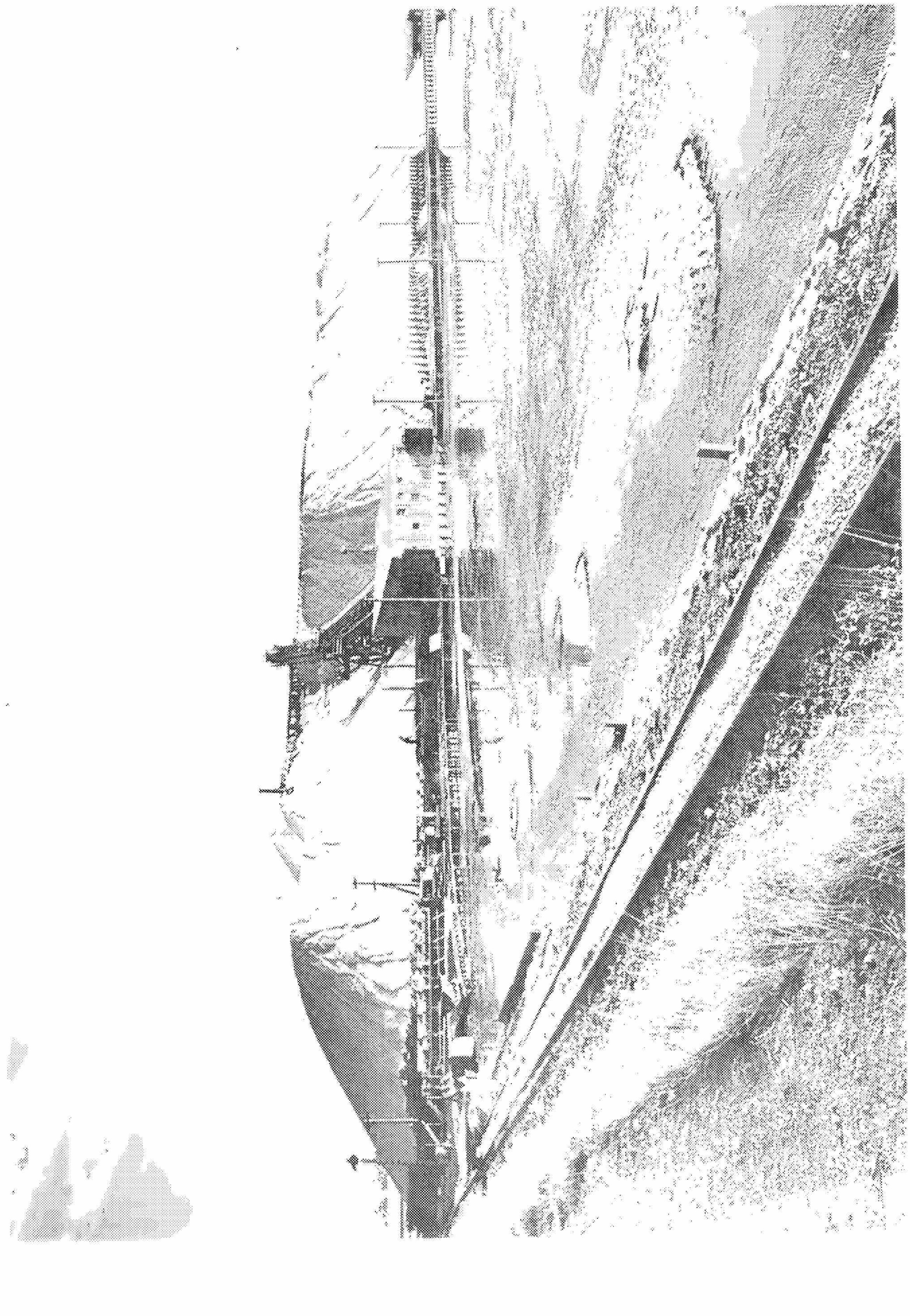


FIGURE 7. Newark No. 1 crude salt plant, Leslie Salt Co., Jarvis Road, Newark. The Newark No. 1 plant was built as plant No. 1 of the Arden Salt Company which obtained its first crop of salt in 1919. The present washer, which has a design capacity of 100,000 tons a year, was built in the early 1920's to replace an earlier plant at Dumbarton Point. *Photo by Gabriel Moulin Studios, courtesy Leslie Salt Co.*

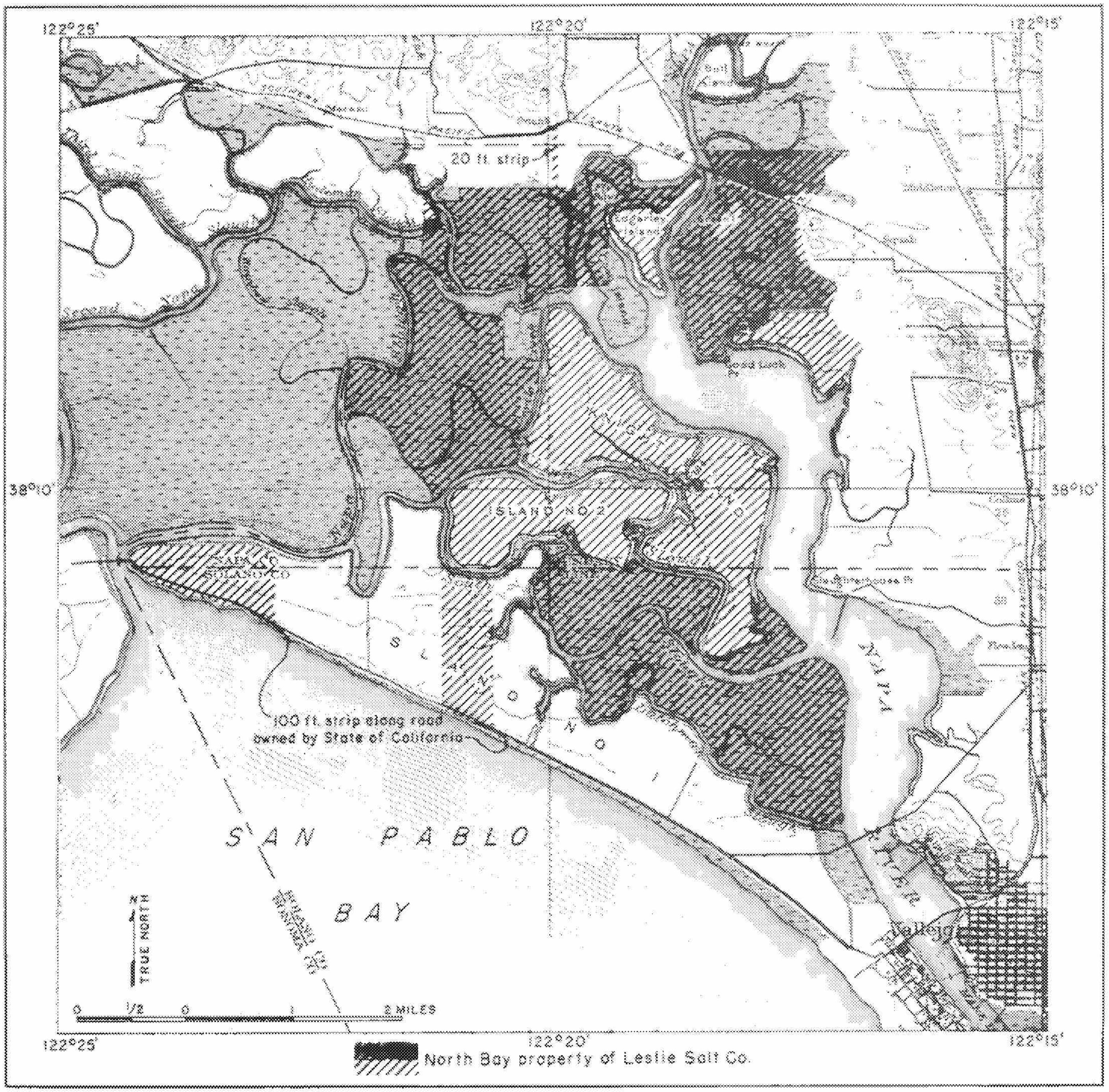


FIGURE 8. Map showing location of Leslie Salt Co.'s North Bay property as of July 1952.

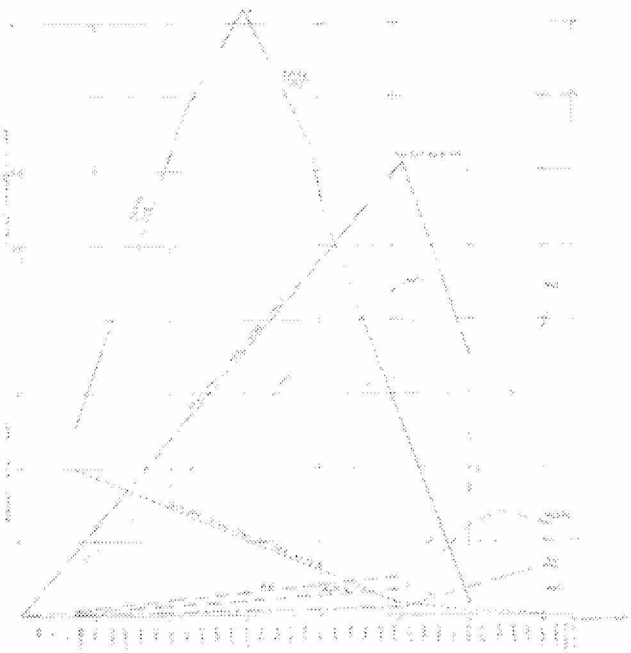


FIGURE 9A. Graph showing the composition of normal brine at various concentrations.

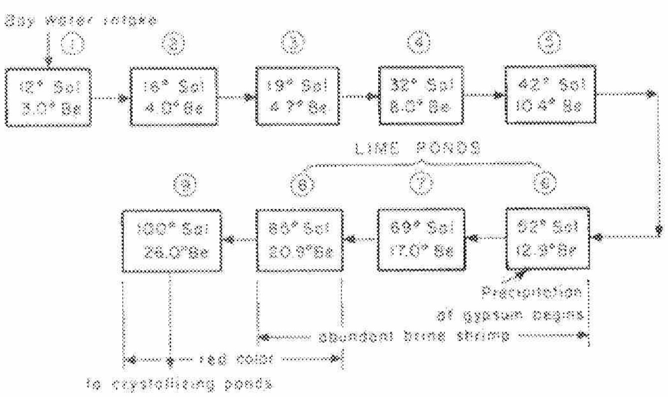


FIGURE 9B. Diagram illustrating the progress of brine concentration in a series of concentrating ponds.

are required. The amount of water evaporated is 29,000,000 tons, yielding 800,000 tons of salt and 800,000 tons of bittern.

Interesting biological changes take place in the evaporating ponds (Peirce, 1914). Pond one contains live fish and the numerous micro-organisms present in sea water, and the water is muddy. In ponds two, three, and four (4°-8° Be) the sea water forms are dying, and new forms of life are appearing. In pond five (10° Be) no fish remain alive. Gray colored brine shrimp (*Artemia salina*) and yellow algae (*Dunaliella viridi*) appear and thrive on dead matter. The algae color the water yellowish. Shrimp and algae continue to thrive in ponds six and seven (13°-17° Be), and the shrimp aid in the precipitation of calcium carbonate and calcium sulfate. Additional micro-organisms appear in pond eight (20° Be) including red chromogenic bacteria that color the water red. Shrimp feed on the red bacteria and turn from gray to red. Algae and shrimp are dying in pond nine (26° Be). The red bacteria remain healthy until the brine has become a bittern of specific gravity 34° Be. As they die and settle to the bottom the bittern turns from red to light brown in color.

Bay water is taken in during the highest tides and when the salinity of the water is highest. Depending on the year, the intake period begins in April or May and lasts through October or November. During the winter little if any evaporation occurs, and the concentrating ponds lie idle. Rain water lies on the surface of strong brine and does not mix with it appreciably unless the wind is strong. A year is believed to be required for raw bay water to pass through the concentrating ponds and reach the pickle pond. Pickle is available for flooding the crystallizing ponds as soon as the winter rains are over, usually in April.

The Crystallizing Ponds

The ratio of concentrating to crystallizing pond area is about 15 to one, considerably more than the theoretical ratio of ten to one. The extra area of concentration pond is required because of pond leakage and dilution by rain water. Crystallizing ponds are rectangular in shape and have flat, grass-free bottoms with a slope of 1 inch per 300 feet to one corner to facilitate emptying. Individual ponds range from 20 acres or less to more than 60 acres in size. The size is determined by the capacity of the harvesting machine. With smaller ponds more time is lost in transferring equipment from one pond to

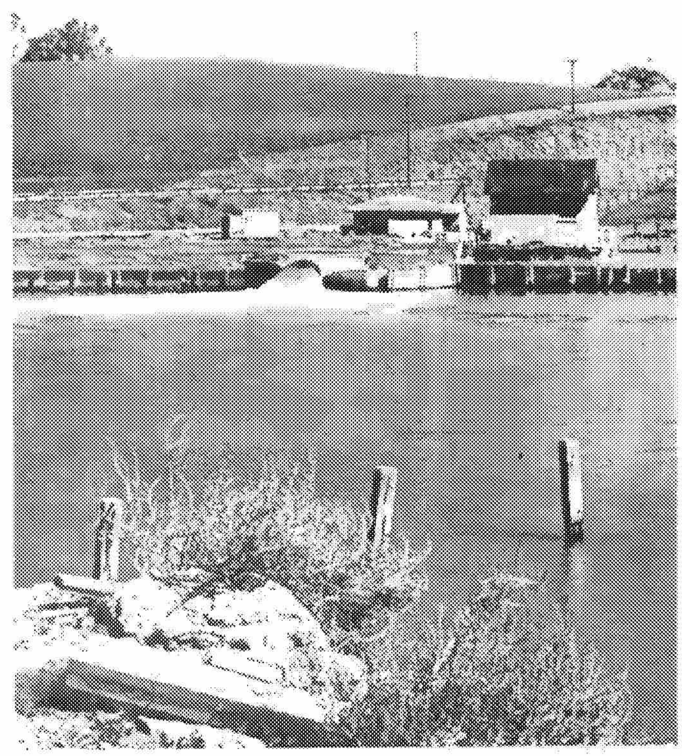


FIGURE 10. Pumping brine. Intake pump of Newark No. 1 crude salt plant, Leslie Salt Co. Wherever possible brine is partially concentrated and its volume reduced before handling it with pumps. *Photo courtesy Leslie Salt Co.*

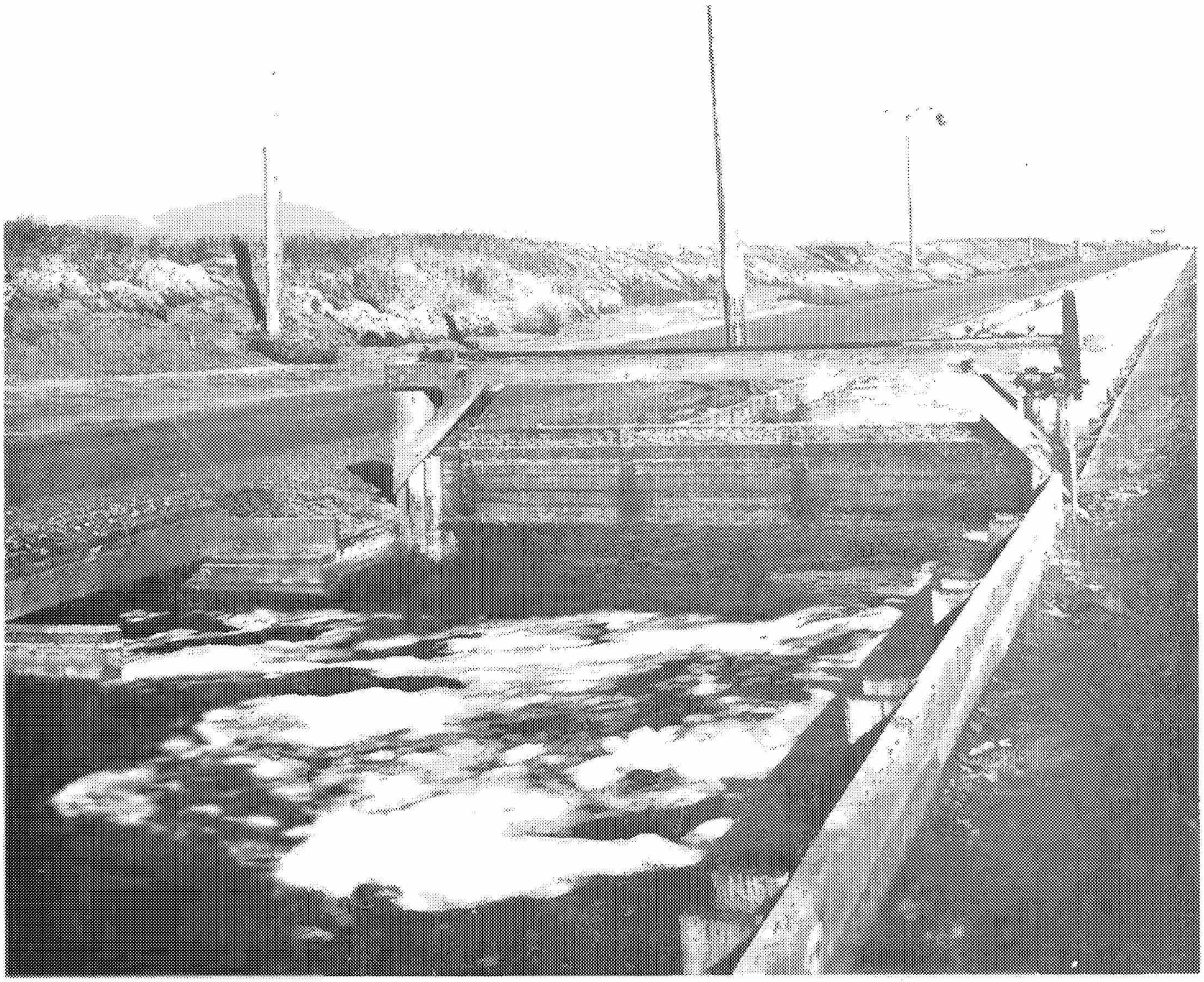


FIGURE 11. Brine ditch with control gate, Leslie Salt Co. The flow of brine between ponds is controlled by gates that are reached by roads built on the levees. *Photo courtesy Leslie Salt Co.*

another, while with larger ponds salt is left exposed for a longer time.

Crystallizing ponds are provided with an elaborate system of ditches and pumps for rapid filling and emptying. Two 40-horsepower pumps of 5,000 gallons per minute capacity serve the crystallizing ponds of the Newark number 2 plant; and for maximum flexibility and control, pickle may be drawn from any of the last three concentrating ponds.

Pickle flows from the supply ditch to the concentrating ponds, and from thence bittern ditches carry bittern away. Close control is required to prevent, as far as possible, the precipitation of either gypsum or bittern salts in the crystallizing ponds. Pickle enters at 25.6° Be, and bittern is withdrawn at 29° Be. An effort is made to keep the specific gravity within these limits by continuously drawing off a small amount of bittern. Two to five times during the season, however, it is necessary to empty the ponds and refill them with fresh pickle.

As evaporation continues, tiny seed crystals of salt form on the surface and are supported by surface tension. As their weight increases, they sink deeper. Growth is fastest on the upper edges, and distorted, hopper-shaped crystals form. Crystals sink when they are heavy enough to overcome surface tension. Large intergrown crystals form on the bottom, often with faces two inches or more long. During the season 4 to 6 inches of salt forms, and about 70 percent of the salt in the pickle is extracted.

Bittern is brought from the crystallizing ponds to bittern ponds where further evaporation raises the specific gravity to 30° Be, and some additional salt forms. The Westvaco Chemical Division of Food Machinery and Chemical Corporation currently purchases all of the bittern that the Leslie Salt Co. produces. The facilities for transferring the bittern from the various bittern ponds to storage reservoirs are owned and operated by the chemical company.

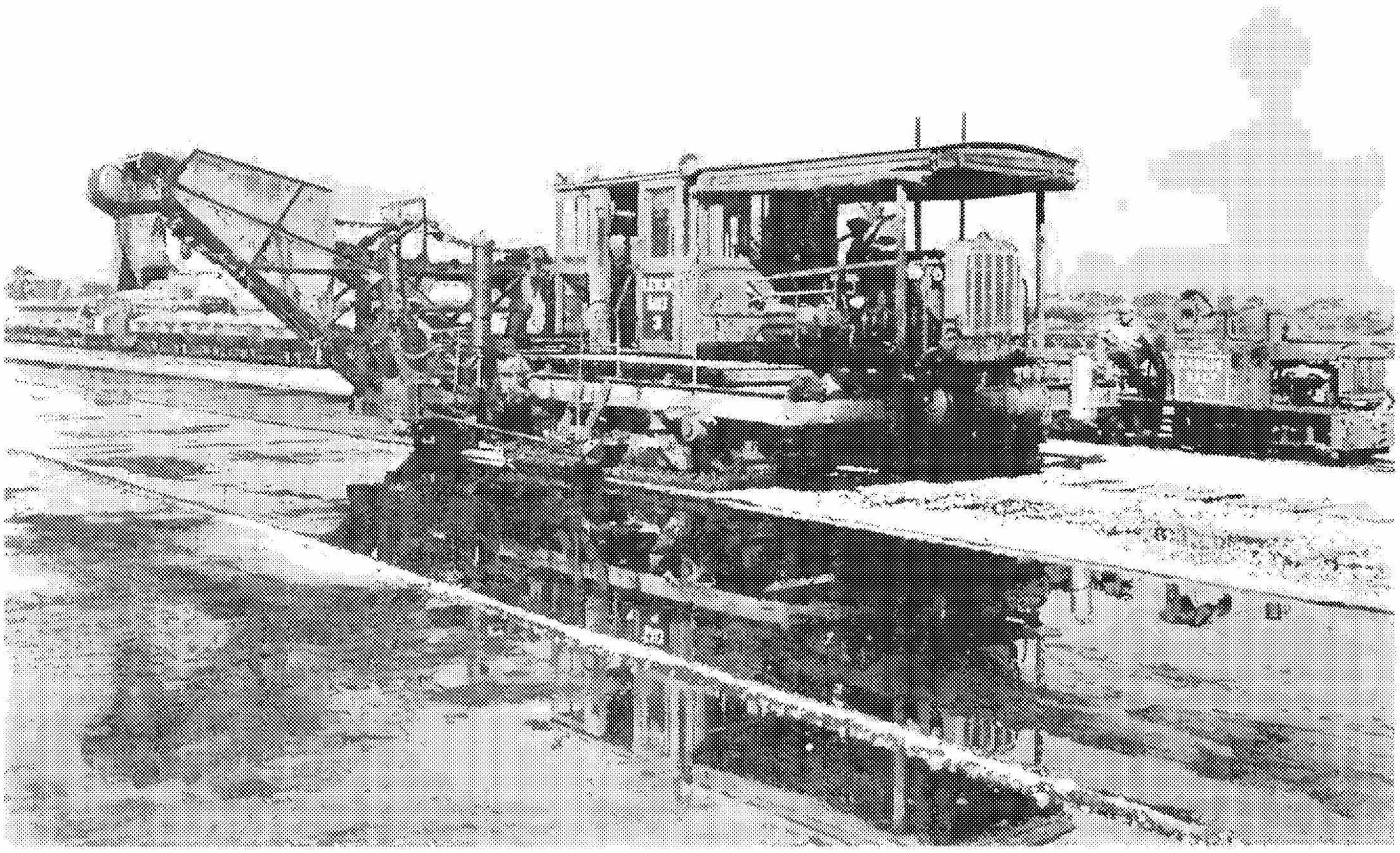


FIGURE 12. Harvesting machine, Leslie Salt Co. A view from the side. The cutter, which is mounted on the rear of a caterpillar type tractor, is essentially a horizontal, revolving shaft bearing picks. Salt is broken free by the picks and thrown onto a short drag conveyor that carries it to the waiting cars. When the salt is four inches thick, loading is at the rate of 150 tons per hour. *Photo by Gabriel Moulin Studios, courtesy Leslie Salt Co.*

*A typical analysis of bittern at 30° Be.**

	Percent
$NaCl$	12.5
$MgCl_2$	8.7
$MgSO_4$	6.1
KCl	1.9
$MgBr_2$	0.18

* After Seaton, 1931.

After the bittern ponds have been emptied the salt that forms in them is dissolved with weak brine and returned to the concentrating ponds. This salt is of the same high quality as that which forms in the crystallizing ponds. Above 29° Be, however, the rate of crystallization is so slow that it does not pay to keep the bittern in the crystallizing ponds any longer.

The Harvest

Mechanization makes it possible to continue the crystallizing season into the fall yet to complete the harvest before the winter rains begin. Harvesting starts around October first and continues 24 hours a day, seven days a week until it is finished, usually toward the end of December. One pond at a time is drained and harvested. Salt is left uncovered in the ponds for as short a time as possible. Not only does salt harden upon exposure to the air, but the thin layer of salt spread over the broad pond is particularly exposed to showers when it is not covered with pickle. In addition, no salt forms after the pond has been drained.

The Harvesting Machine. The harvesting machine is a unique piece of equipment that was perfected in the 1930's. The cutter, which is mounted on the rear of a caterpillar-type tractor, is essentially a horizontal, revolving shaft bearing picks. Salt is broken free by the picks and thrown onto a short transverse drag conveyor. The conveyor is carried by means of wings to loading chutes, one on each side; and the conveyor is reversible so that loading is done on either one side or the other. The tractor, which is supported on wooden tracks about

FIGURE 13. Harvesting machine, Leslie Salt Co. A close view from the front.
Photo by Elmer Moss, courtesy Leslie Salt Co.

five feet wide, runs on the salt and drags the cutter behind it. The elevation of the cutter, the conveyor wings, and the loading chutes are adjusted hydraulically. The harvesting machine cuts a swath 13 feet 8 inches wide and 4 to 6 inches deep. The speed may be varied from 5.34 feet per minute to 16.7 feet per minute. When the salt is four inches thick, loading is at the rate of 150 tons per hour.

Six machines are in operation, one older machine is held in reserve as a spare, and an additional machine is under construction. Three are powered with D-7 diesel tractors, three with D-6 tractors, and the older machine has a gasoline engine. Two are used at the Newark number 2 plant, two at the Redwood City plant, and one each at the Newark number one and Baumberg plants.

Transporting the Salt. Salt is transported from the ponds in narrow-gage cars. Trucks would be difficult to use because the salt has limited bearing capacity and because of the possibility of tracking stones from the gravel roads onto the salt. The railroad systems that serve the four salt producing units total approximately 75 miles of track and have 26 locomotives. Four-ton Vulcan gasoline-powered locomotives comprise the greater part of this number, but there are a few five-ton gas-electric locomotives and some other experimental models. Four Caterpillar straight diesel locomotives are under construction. The track gage is 24 inches at the two Newark plants and 30 inches at the Baumberg and Redwood City plants. Except at Newark Number one, where side dump cars are used, the cars have wooden bodies and bottom dumps. They have a capacity of about two tons of moist salt and weigh 1500 pounds. Permanent tracks are laid on the levees and temporary tracks on the salt in the form of a loop so that the trains always run in the same direction.

The Harvester in Operation. In the harvesting operation the basic unit consists of the harvesting machine,

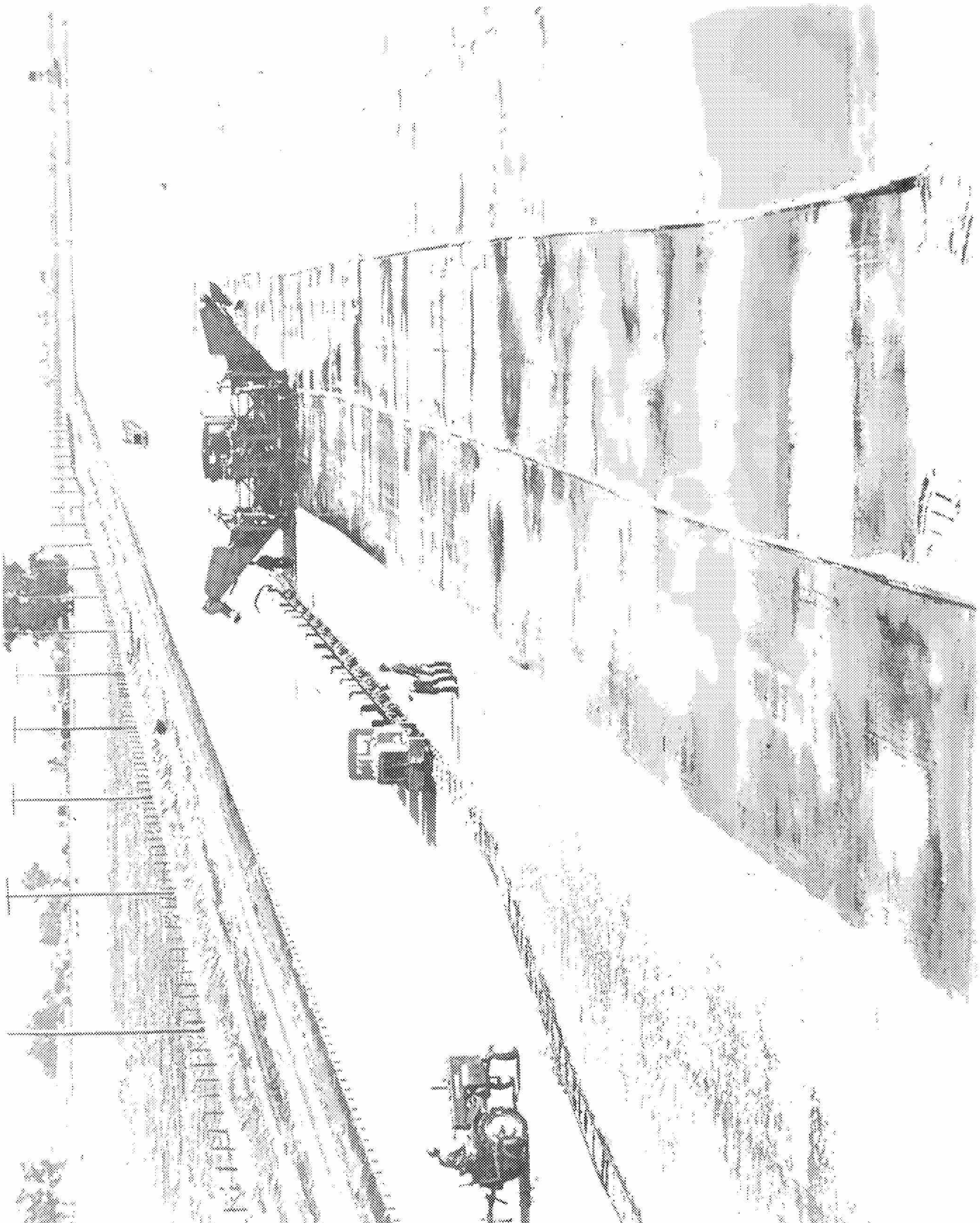


FIGURE 14. The harvesting machine in operation, Leslie Salt Co. Each harvesting machine is served by four trains of 12 to 14 cars. Permanent tracks are laid on levees and temporary tracks on the salt. *Photo by Elmer Moss, courtesy Leslie Salt Co.*

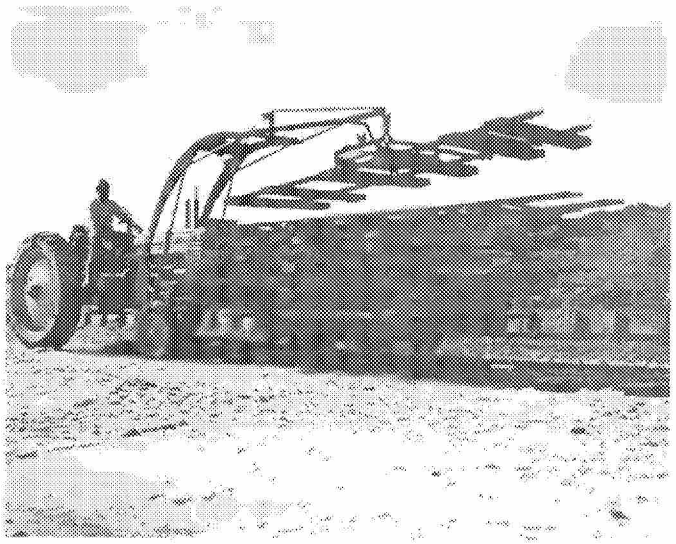


FIGURE 15. Equipment for laying portable track in the pond, Leslie Salt Co. *Photo by Elmer Moss, courtesy Leslie Salt Co.*

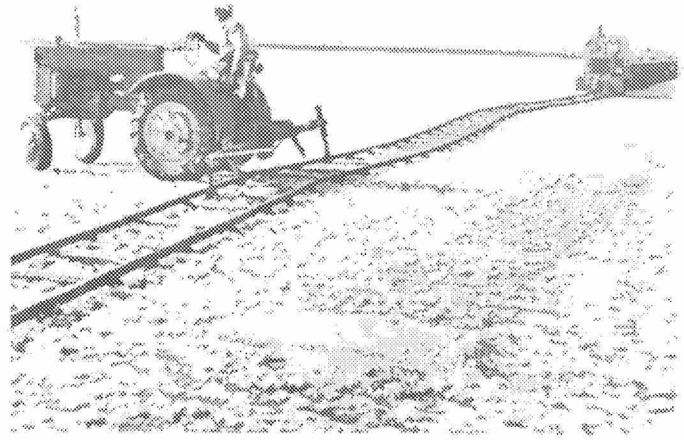


FIGURE 16. Track shifting, Leslie Salt Co. After the harvesting machine has passed, the track is shifted with a tractor equipped with a special tool bar. Traffic is not interrupted. *Photo by Herrington-Olson, courtesy Leslie Salt Co.*

washer, four trains of 12 to 14 cars each, and track shifting equipment. At Newark number 2, where there are two machines, each operates entirely independently of the other and has its own dumping pit. Nine men are required: two men on the harvesting machine, four locomotive operators, one man plus one helper to operate the track shifting equipment, and one at the dumping pit.

The loading machine cuts a swath parallel to the long side of the pond. Trains run on portable track laid on the salt parallel to the swath and are loaded as they slowly pass the moving machine. Thirteen cars are heap loaded in 8 minutes. At the end of the swath the machine is turned around and cuts another swath parallel to the one just completed. In this way the harvest progresses across the pond.

After the harvest the crystallizing ponds are flooded with weak brine to dissolve any salt that remains, particularly fine salt that accumulates on the windward sides. The brine is returned to intermediate concentrating ponds, and the crystallizing ponds are prepared for the next season. They are allowed to dry almost to the point where dust would blow from them, then leveled with scrapers and rolled.

Portable Track. The portable track is built of panels about 15 feet long composed of light rails permanently fastened to light steel or wooden ties. In laying the portable track, panels are brought to the pond on flat cars, and the track is extended onto the salt from spurs of the permanent tracks on the levees. A rubber-tired tractor with a special boom places the panels in position. After a panel has been loosely joined with splice bars to the track already laid, the tractor pulls the flat car ahead and places the next panel.

Track is shifted without uncoupling it after the harvesting machine has passed. A rubber-tired tractor equipped with a special tool bar moves it to the new position, one section at a time, without interrupting traffic. One tractor operator and a helper are required.

Special materials are not required for equipment used about the ponds. For most purposes ordinary iron is practical if corrosion is combatted with a rigorous program of scraping and painting. Some pump sumps and flumes are constructed of wood.

Washing

Salt is washed immediately after harvesting and then placed in outside storage piles. The salt from the ponds contains on the average 97.8 percent NaCl. Impurities are mud scraped up from the pond bottoms, gypsum, which cannot be entirely prevented from precipitating in the crystallizing ponds, and adhering bittern. Washed salt in the stacks contains 99.4 percent NaCl.

The washers at all four plants are essentially the same but have had additional equipment added to increase their efficiency. The basic operation is a wash with concentrated brine in a mechanical classifier that separates the salt from the dirt. This may be followed by additional brine washes and a fresh water spray to remove the adhering magnesium-bearing brine.

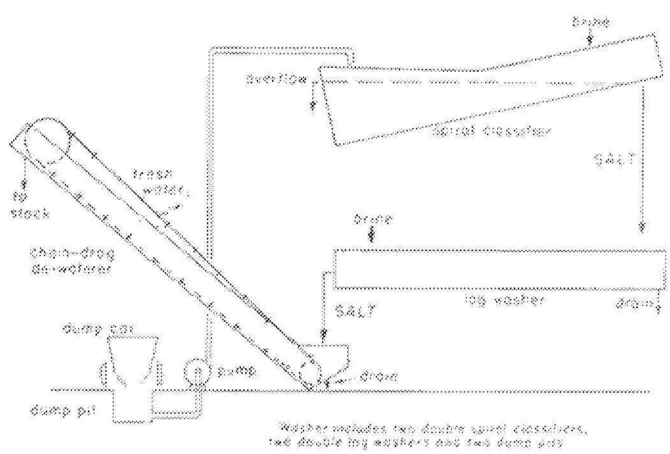


FIGURE 17. Typical washing plant, Leslie Salt Co.

FIGURE 18. Dumping salt at the washer, Leslie Salt. Co. The cars are discharged into rectangular brine-filled pits beneath the track. *Photo by Gabriel Moulin Studios, courtesy Leslie Salt Co.*

At the Newark number 2 unit, the washer is built in two nearly identical sections, one for each harvesting machine. Cars dump into rectangular pits inside the washer house and beneath the track. The dumping pits contain concentrated brine, and centrifugal pumps transfer the salt in slurry form to two washing tanks, each of 150 tons per hour capacity. At the Redwood City plant, the dumping pit and washer are separated by about half a mile of pipe line.

Each washing tank contains a double 2- by 20-foot spiral classifier that provides violent counter-current agitation. Dirty wash brine overflows from one end, while dewatered salt is raised from the other. The washing tanks are followed by vibrating screens that reject plus 1 inch material, mostly clay balls; and the undersize goes to double steel 2- by 20-foot log washers where the remaining lumps of clay are broken up. The streams from the two sections of the washer unite in an inclined 10 by 100-foot dewatering drag, the lower section of which is perforated to allow the salt to drain. After a final spray of fresh water, the salt is sent to storage. Dirty wash brine from all parts of the washer is collected and returned to the wash brine circulating pond where dirt and gypsum settle. Some wash brine is continuously bled off and replaced with fresh pickle to prevent the build-up of magnesium salts. The wash pond must be cleaned of accumulated sediments every few years.

Salt Storage

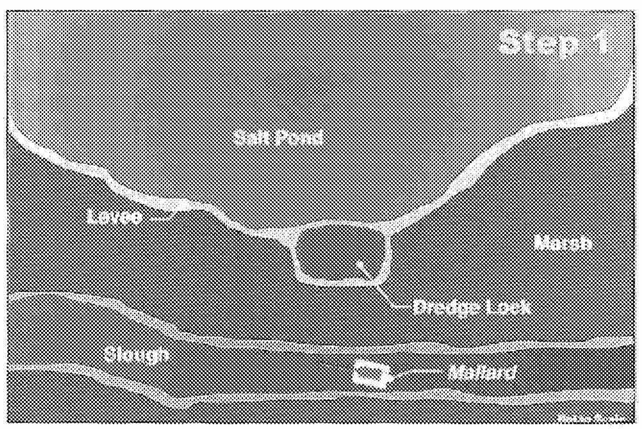
The gantry stackers that are familiar landmarks at Newark and Baumberg were designed by engineers of the Arden Salt Company, one of the Leslie Salt Co.'s predecessors. A trestle 50 feet high and 600 feet long carries a conveyor belt that receives salt from the washer. The gantry tower straddles the trestle on legs

EXHIBIT 4

1/ Minimize Physical Impacts

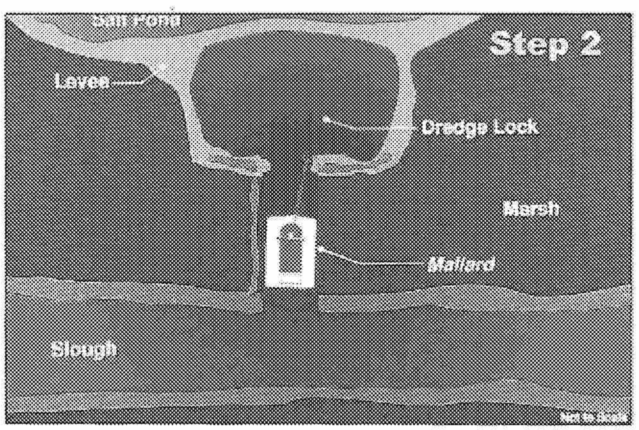
Probably the most significant issue during the extensive negotiations leading up to the issuance of the Corps and BCDC permits was a concern about the impact or "footprint" of routine levee maintenance operations on the habitat and, by extension, sensitive species surrounding portions of Cargill's ponds and facilities. The issue was debated at great length and led to an extensive internal review of maintenance practices by Cargill Salt staff.

Although the field reviews indicated that Cargill's maintenance efforts were being conducted in a responsible manner, the company was challenged to ensure that existing best management practices were used consistently in all areas of the system and to improve upon them, where possible. The reviews established a benchmark for evaluating improved practices. For example, concerns were expressed about dredged muds slipping off levees after being placed on the levee crown by the dredge. Past levee maintenance practices were reviewed, and "slipouts" were measured and photographed. Approximately 96% of the dredged muds were correctly placed, so that became the benchmark upon which to improve. The new best management practices were implemented when authorized maintenance work resumed in 1995 following a 30-month shutdown.



What's a dredge lock?

Dredge locks are small earthen structures, approximately one to three acres in size, that allow the *Mallard*, Cargill's maintenance vessel, to access a system of salt ponds from the adjoining slough or the bay with minimal mixing of brines and bay water and no discharge of brines into San Francisco Bay.



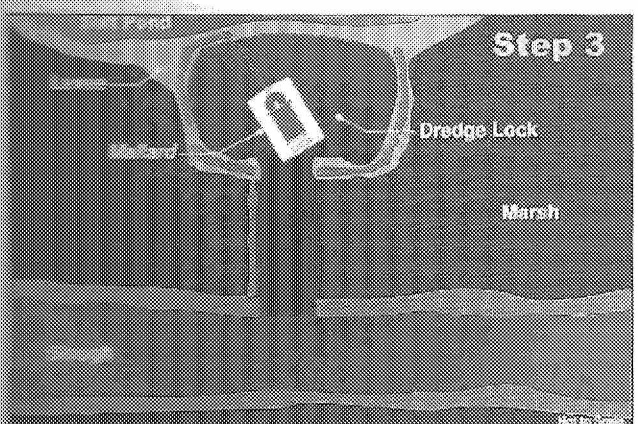
The *Mallard*, which pulls itself along with its clamshell, normally must cut through a shelf of marsh vegetation to reach a lock. If the lock is within reach of the boom, excavated materials will be placed on the lock sides. More typically, locks require dredged muds to be temporarily placed to the side of the access cut. The 36-foot *Mallard* normally makes a cut about 40 feet wide. The *Mallard* 's crew excavates the minimum amount necessary to float into the dredge lock on a high tide.

Best Management Practices – Levee Maintenance

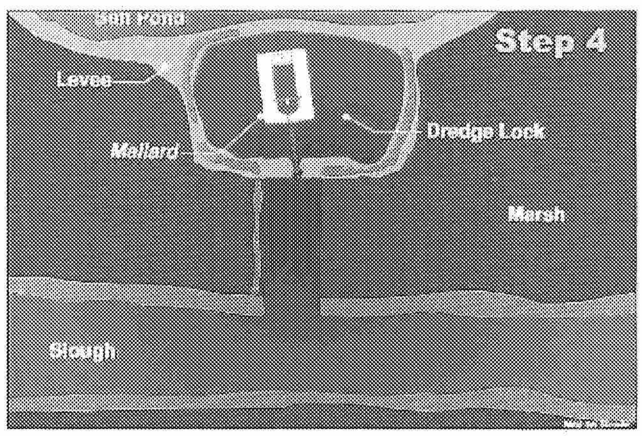
To help Cargill Salt monitor its progress, outside consultants have been retained to measure physical impacts to adjacent marsh area from the use of dredge locks and from the levee maintenance work itself. That analysis indicates that Cargill Salt has successfully reduced the "footprint" of its operations and that best management practices have helped to encourage rapid revegetation of impacted areas.

Cargill Salt has reduced the estimated area impacted each year by 25% from the benchmark established in 1995. Impacts resulting from cuts, sidecasting and slipouts have been reduced by 47%. The analysis of ground surveys of the seven locks accessed between 1995 and 1999 indicate that vegetation on the lock levees, stockpiles and cut areas has substantially recovered approximately three years after access.

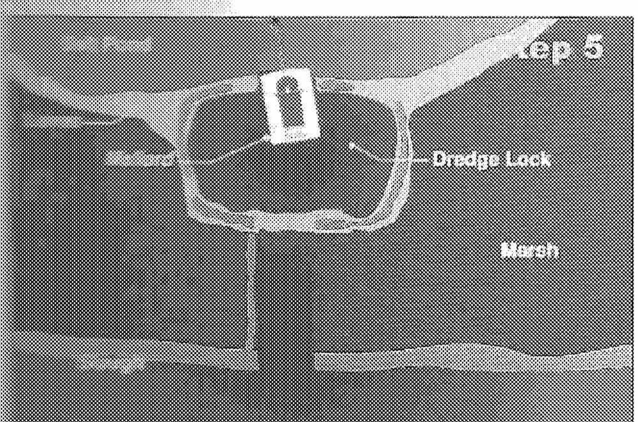
Cargill's solar staff has continued to refine and expand upon the best management practices outlined as special permit conditions. Those refinements follow.



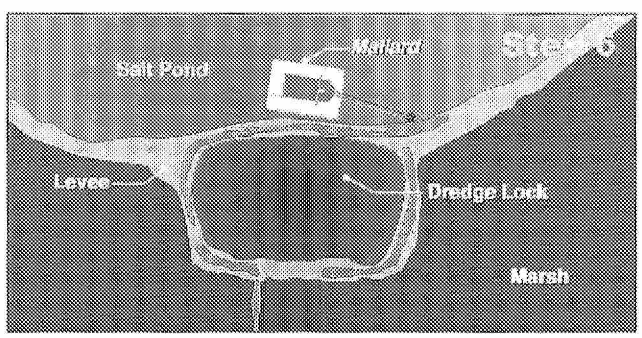
Once in the access cut, the *Mallard* cuts a temporary breach in the lock levee, then pulls itself up to the dredge lock and floats through at high tide.



Once inside the lock, the *Mallard* turns and closes the lock behind itself.



The *Mallard* then turns once again, breaches the pond levee and enters the pond



The lock is then closed. Once inside the salt ponds, the *Mallard* pulls muds from the "borrow pit" inside the salt ponds and places the dredged muds on the levee tops to compensate for subsidence and wind and wave erosion. The same process is repeated in reverse when leaving the pond system. The *Mallard* replaces the displaced muds in the access cut and replants the vegetation.

Earthen berms

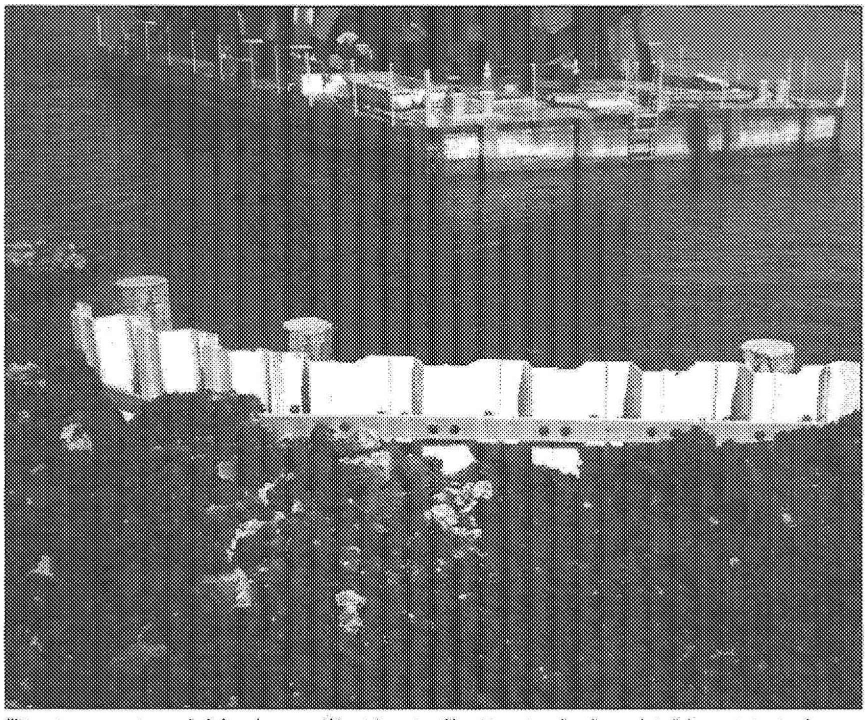
It had been common practice for some time to create earthen berms or "chokers" on the outboard side of the levee tops to contain wet, newly dredged muds. In keeping with Cargill's goal to minimize physical impacts, the size and extent of the berms was increased. These changes resulted in a corresponding decrease in the extent and size of slipouts. For the past five years, Cargill has achieved 100% compliance with the prohibition against allowing dredged muds to slip off the levees and into the adjoining marshes. Slipouts have been virtually eliminated. In the very infrequent occasions when small amounts of mud have slipped past the chokers, the crew immediately removes the muds with either the dredge bucket or hand tools.

Mud replacement

Revegetation of the dredge lock access cuts has improved significantly by carefully replacing dredged muds into the access channel as the dredge leaves a pond system after the levee maintenance program has been completed. Rebuilding the channel to the correct marsh elevation creates a stable platform for newly emergent vegetation. In the past, dredged muds were not replaced due to a perception that this would constitute a prohibited "fill" in the marsh. The resulting excavation was restored only by an accumulation of silts over a period of time that varied considerably from one area of the system to another. The new BMPs provided for reconstruction of the marsh plain, which facilitates revegetation.

Temporary piling

Newly dredged muds have a high water content and often are not sufficiently cohesive to remain in place when exposed to tides and other erosive forces. As a further refinement of the BMPs, Cargill staff has used temporary, recyclable sheet piling to contain highly saturated muds within the access cut. The sheet piling is placed across the mouth of the access cut at the entrance to the slough. The inert, fiberglass sheets remain in place while the dredged muds settle, drain and consolidate into a cohesive mass that integrates with the adjoining marsh. The sheet piling remains in place until it is removed by the dredge for reuse at another location.



Temporary, recyclable sheet piling is an effective tool when highly saturated muds must be used to rebuild the access cut.

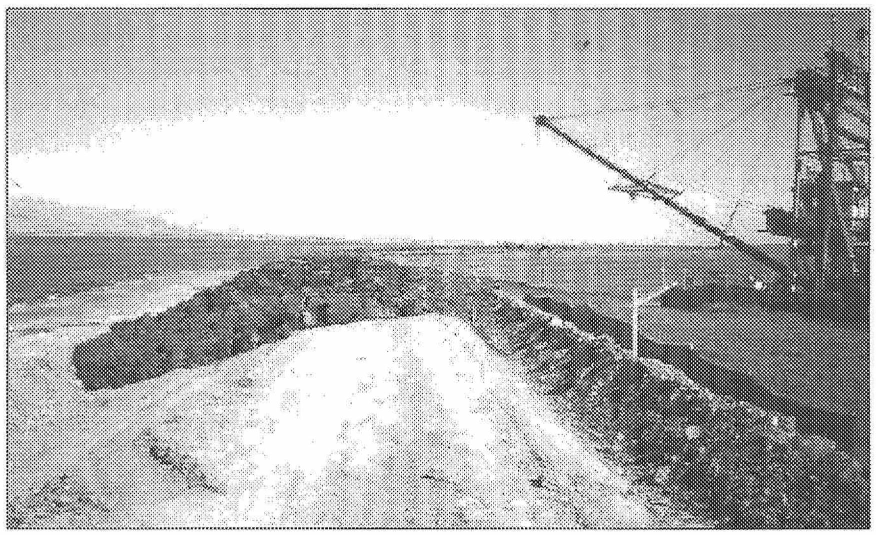
Slough dredging

Slough dredging was another BMP developed during the permit negotiations. This practice also has evolved and is now even more effective. Initially, the ability to dredge cohesive muds from a slough and place them on an adjoining levee was viewed as a means to avoid the need to enter a dredge lock.

If an outboard levee was accessible to the dredge from an adjoining slough and did not require extensive amounts of dredged muds to restore its shape and function, moderate amounts could be excavated from the slough and carefully placed on the inboard side of the levee.

One obvious concern was the potential for muds to slip onto the adjoining marsh so this practice is limited to areas where the dredge has easy access to the levee with its boom.

Almost every year since approval of this practice, it has been possible to avoid entry of a dredge lock by dredging muds from a slough.



In some situations, dredging from the slough side makes it possible to reduce the use of dredge locks.

Reducing temporary impacts

Slough dredging also has evolved into a very suitable practice for reducing the amount of mud that must be temporarily placed in the marsh during dredge lock entry and egress. Previously, muds and marsh grasses removed from the access path leading from the slough to the dredge lock were "sidecast" or placed on the adjoining marsh. The muds were then removed when the dredge exited the lock. The stockpiled muds were picked up by the dredge bucket and replaced in the access cut. While a clear improvement over historic practices, there was still a temporary impact to the adjoining marsh.

Now, when possible, a storage sump is dredged in the adjoining slough. The excavated muds are placed on a nearby levee, and the muds from the access cut are placed in the sump, reducing the amount of dredged muds that must be temporarily stored on the marsh surrounding the dredge lock.

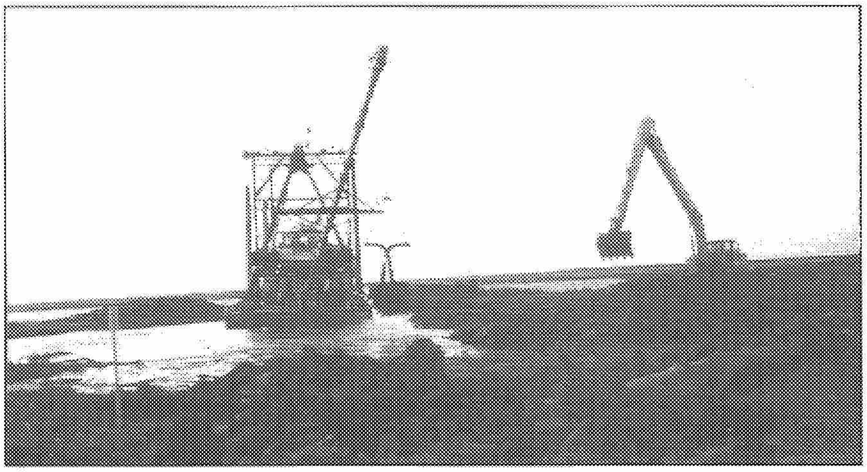
When the muds are to be replaced in the access cut, the sump is again dredged, and the muds are removed and placed in the access cut. This BMP is limited to locations where both banks of an adjoining slough are readily accessible to the dredge. But, when this BMP is implemented, the "footprint" is very much reduced

Stockpile management

Management of stockpiles of dredged muds adjacent to existing locks was a hotly debated issue during the negotiations for the permit. Stockpiles of dry, accessible clay materials must be available for use in restoring the integrity of dredge locks during and after use. The use of berms, chokers and moving stockpiles closer to the levees has reduced the resulting "footprint" of mud stockpiles.

Land-based dredging

The use of land-based dredging equipment was also a subject of debate during the negotiations. Although land-based equipment was found not to be appropriate for most of Cargill's maintenance activities, the company did commit to using land-based equipment whenever possible. The most recent example was the entry of the dredge into the existing lock at Pond 2A in Plant 1. That lock was located at the end of a well-used public access trail within the Don Edwards San Francisco Bay National Wildlife Refuge. Access to the lock was difficult because of the extensive growth of marsh plants through a comparatively long access cut. A land-based excavator was used to assist in excavation of the dredge cut. This reduced the total area affected by the entry of the dredge.



Land-based dredging equipment is used whenever possible.

Relocating dredge locks

In the negotiations, Cargill also agreed to relocate dredge locks, where possible, to less sensitive locations. In 1997, Cargill constructed a new dredge lock in the Alviso system at Pond 19 across from the Newby Island landfill. The new lock replaces an existing lock at Pond A20 that was in a more sensitive area.

Invasive species

While Cargill has made demonstrable progress in minimizing physical impacts and encouraging rapid revegetation, success has been more elusive in the company's efforts to control invasive species such as peppergrass. This perennial has a wide distribution throughout California and is a problem throughout San Francisco Bay in several soil types. To date, no effective control measures have been developed. Cargill has tried a number of measures. The company has tried physically removing peppergrass when entering the lock. The crew also attempted to cover stands of peppergrass on lock levees where accessible. The effectiveness of these measures has been limited. Cargill will continue to work with consulting biologists in an effort to identify more effective control measures as they are developed.

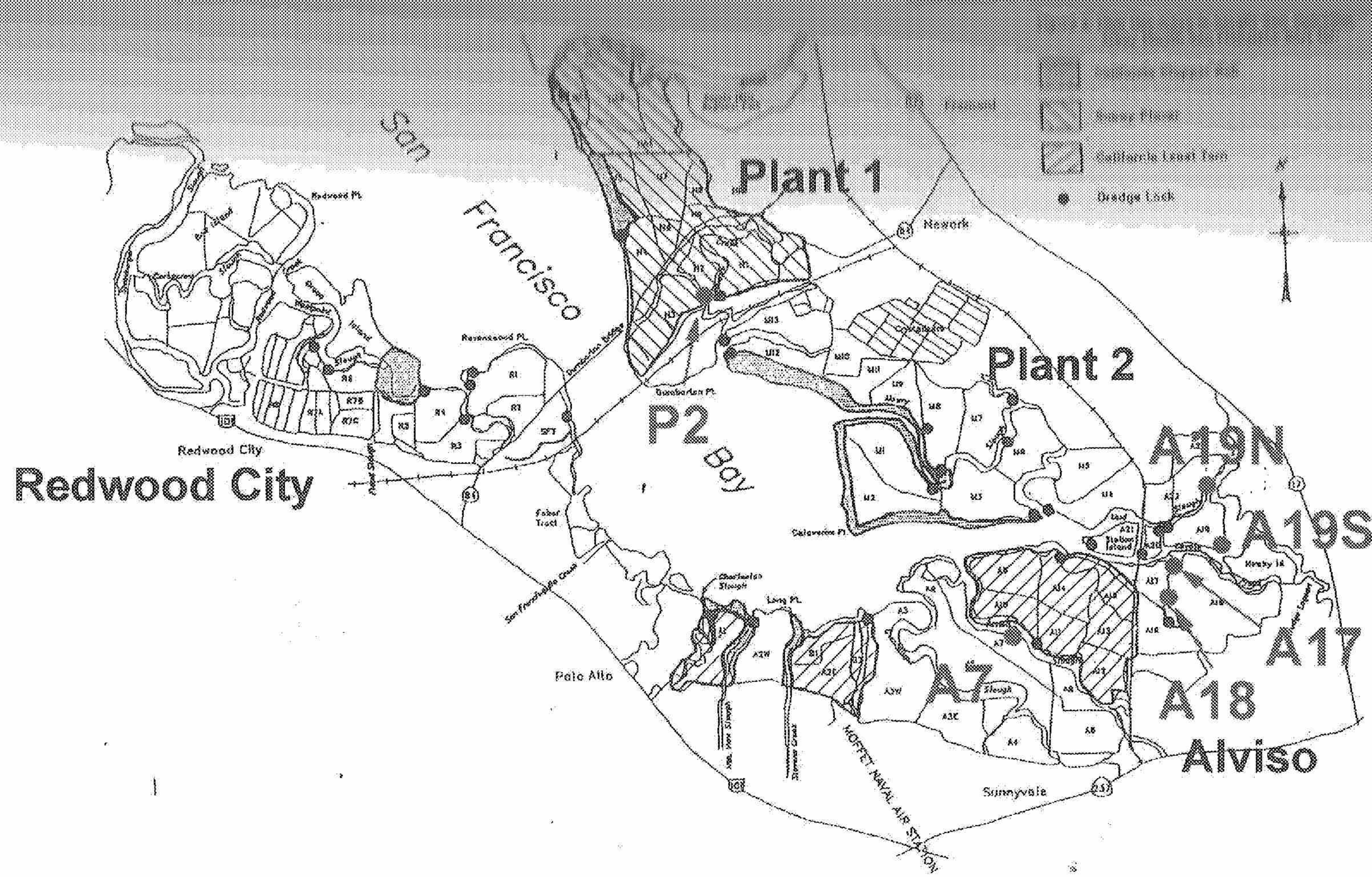


Figure 2. Dredge locks accessed between 1995 and 1999. Vegetation sampling and assessments of BMP and Special Condition implementation were conducted at each site.

Wetlands Research Associates, Inc.

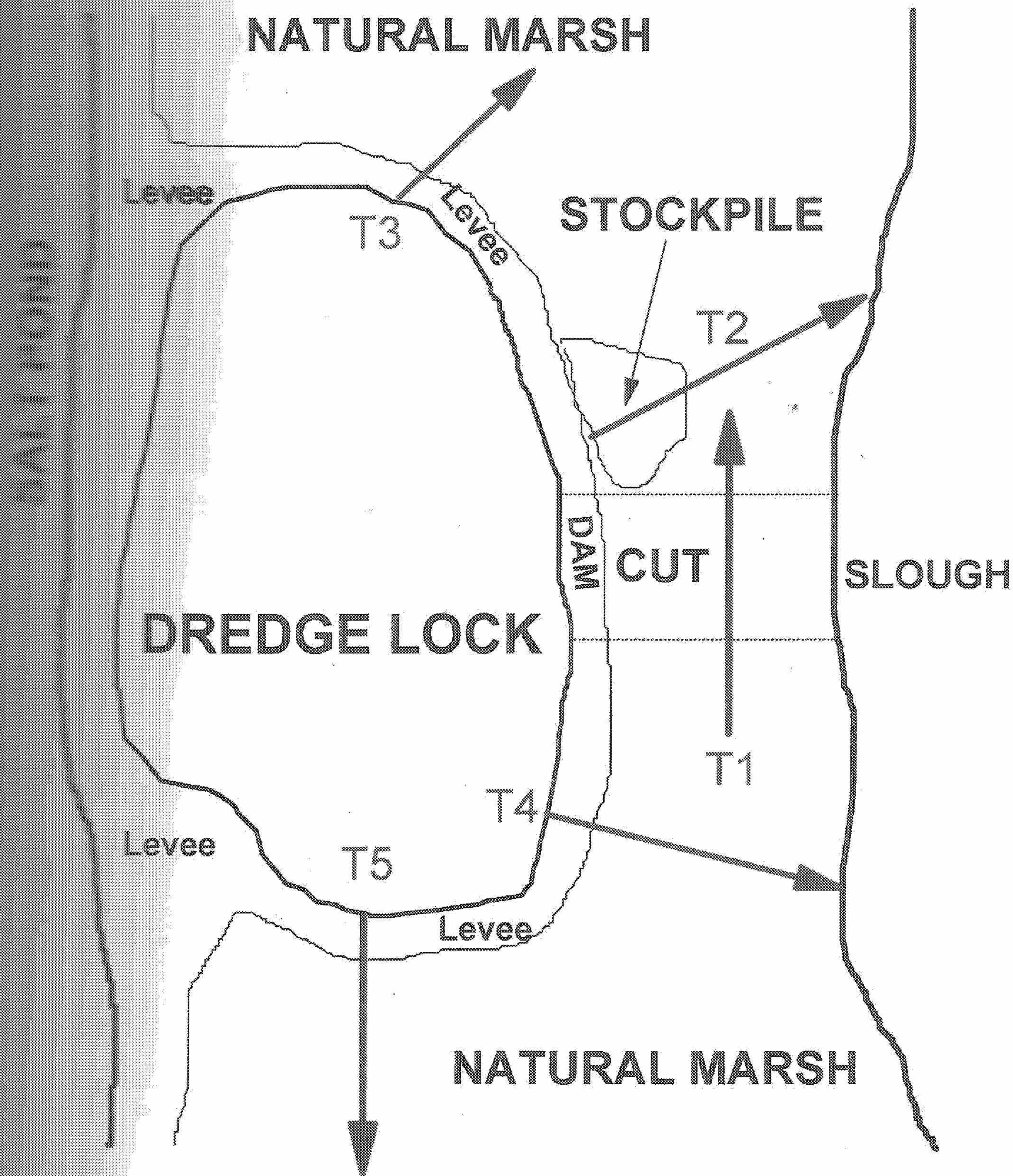


Figure 4. Schematic drawing of typical dredge lock showing locations of vegetation transects across impacted areas of locks.

Wetlands Research Associates, Inc.

EXHIBIT 5

MEMORANDUM FOR RECORD

PROJECT: Cargill Operations and Maintenance Permit
DATE: 1/12/09
SUBJECT: Permitting History, Mallard Use of Redwood City Ponds, and Dredge Lock Access

Permitting History:

From a brief review of the file the following permits have been issued for operations and maintenance of Cargill's salt ponds. Please note there may be permits that were issued prior to 1988.

1) 1988 Regional Permit No. 17040E98
2) 1995 Individual Permit No. 19009S
3) 2008 Nationwide Permit (restricted to inboard levee work) No. 2008-00146S
4) 2008 Individual Permit application submitted by Cargill (currently in review)
5) 2009 Individual Permit No. 2008-00103S (expected to be issued to USFWS/CDFG 1/23)

Record of Section 7 Consultations:

1) 1988 permit included a special condition that states that if the project will modify a federally-listed species that a Section 7 Consultation will be initiated by the Corps.
2) A Section 7 Consultation was concluded prior to the 1995 permit issuance for effects to four federally-listed species California clapper rail, salt marsh harvest mouse, California least tern, and western snowy plover.
3) In addition to the species listed above, Section 7 Consultation was concluded with NMFS for effects to Steelhead and Green Sturgeon for the 2008 Nationwide permit.
4) For both Individual permits, Section 7 Consultation was initiated for effects to seven federally listed species: salt marsh harvest mouse, California clapper rail, western snowy plover, California least tern, California brown pelican, central California coast steelhead, and its Critical Habitat, and green sturgeon.

Maintenance Record at Redwood City:

Since November of 1995, a permit for operation and maintenance has been issued to Cargill for the continued maintenance of levees, water control structures, and other existing structures. As a requirement of this permit Cargill has been required to submit Annual Notifications of Proposed Work and Completed Maintenance Reports. These reports were reviewed to determine when Cargill's floating dredge, the "Mallard", has been used to complete maintenance at the Redwood City Plant. The below list summarizes these results.

- 2003-2004; A new cross levee was constructed with material from the pond. According to report levee was constructed with the Mallard or with land based equipment in pond S5. The Levee is 1,200 linear feet (lf) in length.
- 2001-2002; Levee topping "Mallard" Pond 3; top and beach with dredged muds, cross levee 4,5
- 2001-2002; Enter dredge lock at Pond 4
- 2001-2002; Levee topping "Mallard" Pond 5; top and beach with dredged muds, cross levee (3, 4, S5)
- 2001-2002; Levee topping "Mallard" Pond S5; top and beach with dredged muds, cross levee (4, 5)
- 1999-2000; Levee topping "Mallard" Pond 1; Top levee using slough muds from Ravenswood Slough. 1,800 lf and spot top bay shore levee 5,000 lf outside of salt pond
- 1999-2000; Levee topping "Mallard" Pond 3; Top with dredged muds; majority of system
- 1999-2000; Levee topping "Mallard" Pond 4; Top with dredged muds; majority of system
- 1999-2000; Levee topping "Mallard" Pond 5; Top with dredged muds; majority of system
- 1999-2000; Levee topping "Mallard" Pond S5; Top with dredged muds; majority of system
- 1996-1997; Levee topping "Mallard" Pond 1; Top a total of 5,000 lf of levee using slough muds from outside of salt pond
- 1996-1997; Levee topping "Mallard" Pond 4; Top a total of 2,000 lf of levee using slough muds from outside of salt pond

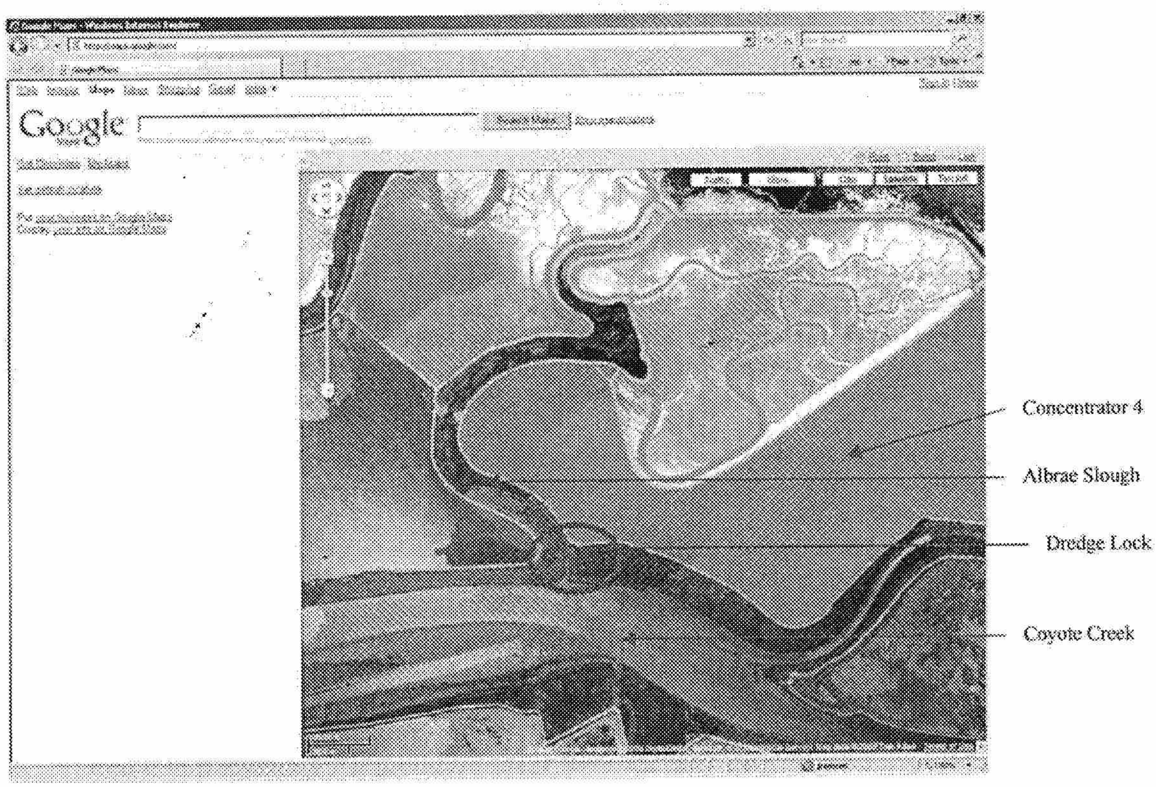
- 1996-1997; Levee topping "Mallard" Pond 10; Spot topping a total of 1,000 lf using slough muds from outside of salt pond
- 1996-1997; Levee topping "Mallard" Pond 9A; Spot topping a total of 500 lf using slough muds from outside of salt pond

Based on this information it appears that Cargill has used the Mallard within the Redwood City site. Mallard work occurs mainly in the concentrator ponds, crystallizers are maintained using excavators and land-based equipment. Cargill has operated the Mallard from both the sloughs outside of the pond system and within the pond system.

Dredge Lock Access:
Paula Gill and Ian Clunies-Ross traveled to Newark Concentrator 4 in Plant 2 on January 7, 2009, to watch the Mallard access the pond via the dredge lock. When we arrived the Mallard had traveled up Coyote Creek into 'Albrae' slough. The Mallard was cutting into the outboard marsh side-casting material as it approached the dredge lock. The Mallard requires at least 4' of water to float and therefore can only operate in the dredge locks near the high tide (from 7 am- 10am on this day). During the site visit the dredge temporarily breached the lock. Cargill estimated that the Mallard would breach the outboard levee and travel into the Newark plant ponds on 1/13/09.

There are dredge locks located at the Newark Plant 1 (2a, 4, 2, and 1), Newark Plant 2 (13, 12, 26, 8, 7, 6, 1, and 4) and Redwood City (9a, and 9).

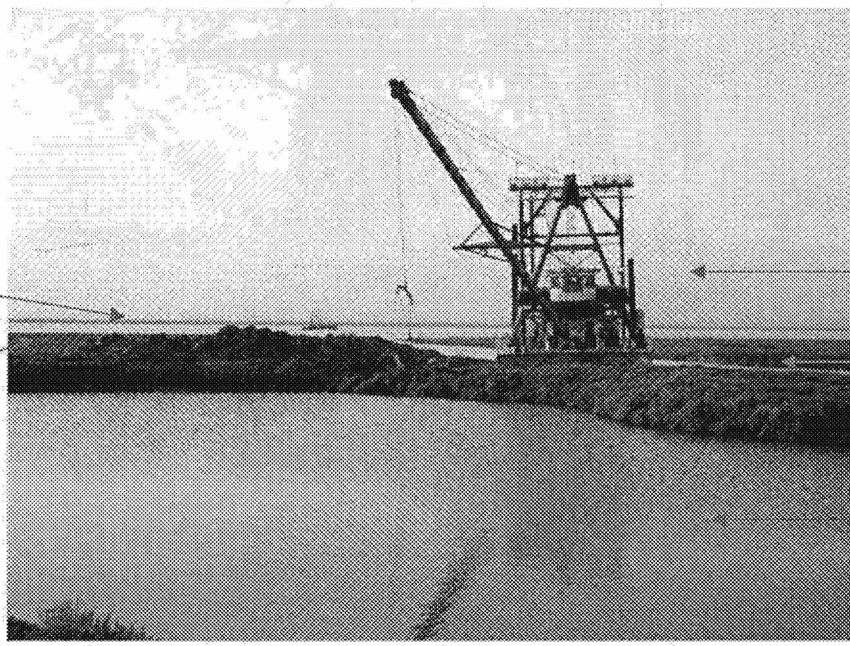
Location:



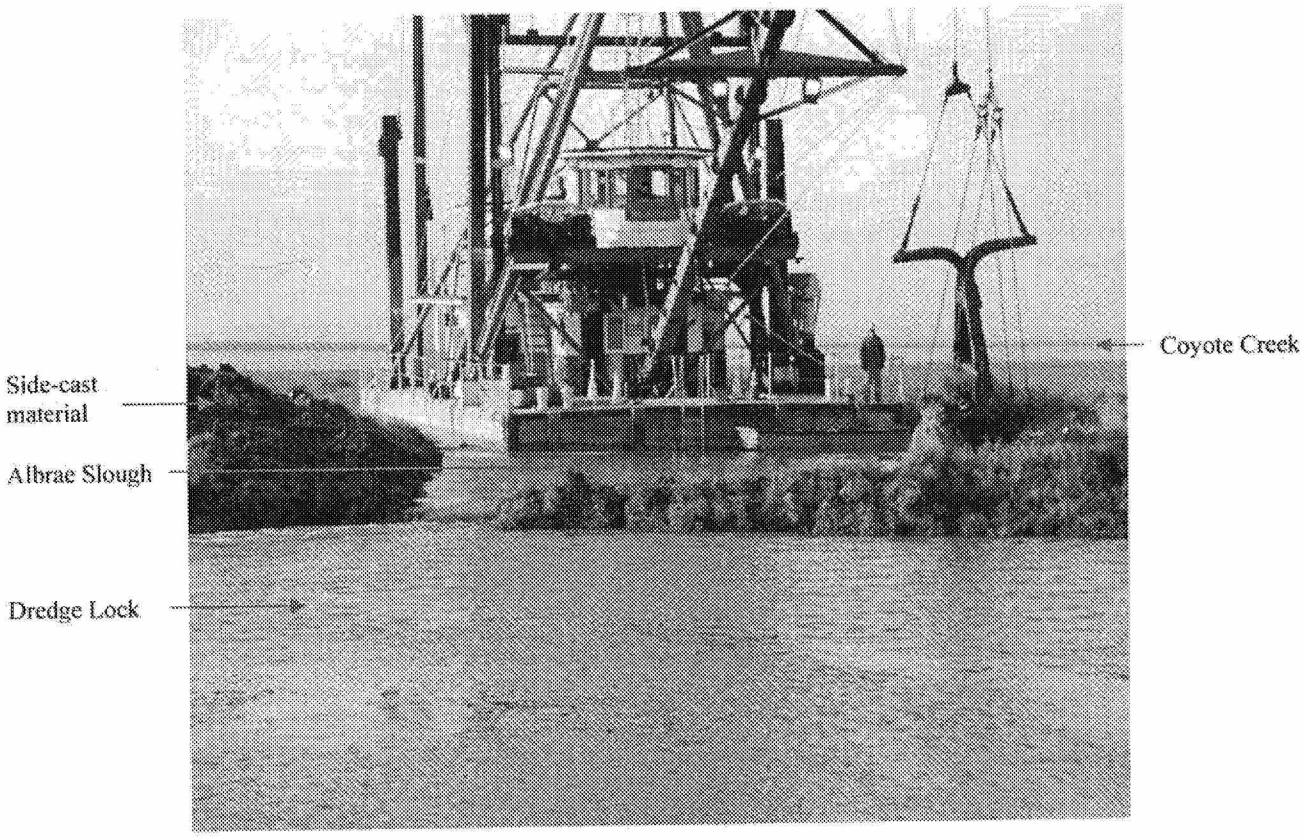
The dredge lock is approximately ½ an acre in size and consists of standing water. Adjacent to the lock intact tidal marsh was observed. The marsh was inundated to the levee foot at the time of the site visit. Observed species included, *Frankenia salina, Lepidium latifolium, Salicornia virginica*, and *Distichlis spicata*. Side-cast sediment appeared to be consistent with typical bay muds, (i.e. gley color and sulfidic odor).

Photographs taken 1/7/09

<u>Setting:</u>

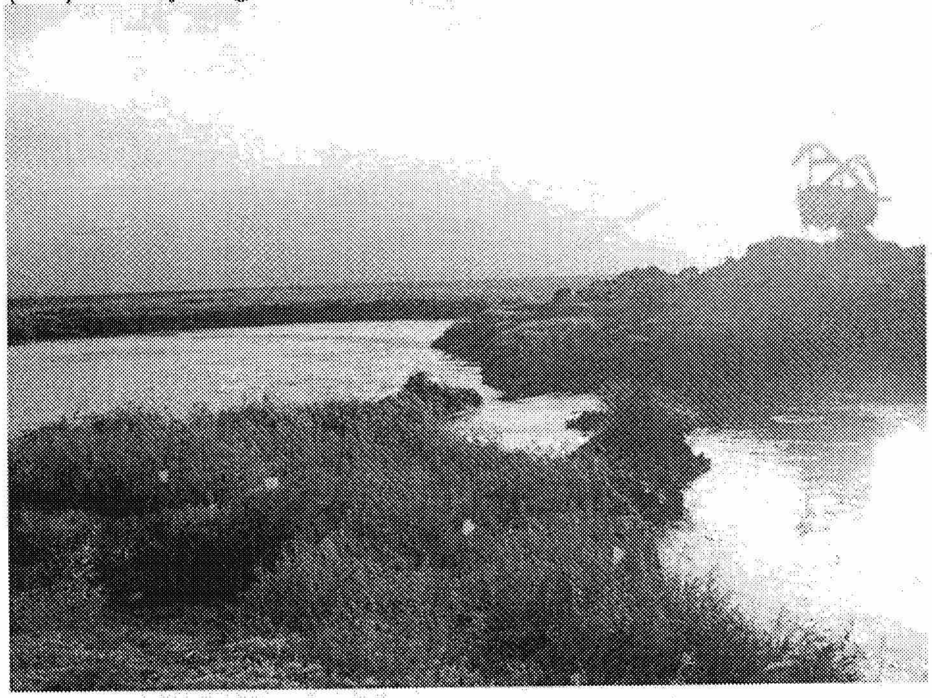


Breach from Albrae Slough to Dredge Lock:



Other photographs:
Photograph was taken standing on salt pond levee looking toward S.F. Bay, Concentrator 4 is behind the photographer. A commercial shrimp boat is visible in back ground. The shrimp is harvested for bait.

Photograph was taken standing on fringe marsh looking toward the dredge lock and Concentrator 4. Photograph depicts the hydrologic connection from the lock to the Albrae Slough.



Photograph was taken standing on fringe marsh looking toward the dredge lock, Concentrator 4, and outboard levee.

Mallard in the process of side-casting material onto fringe marsh to access the dredge lock.

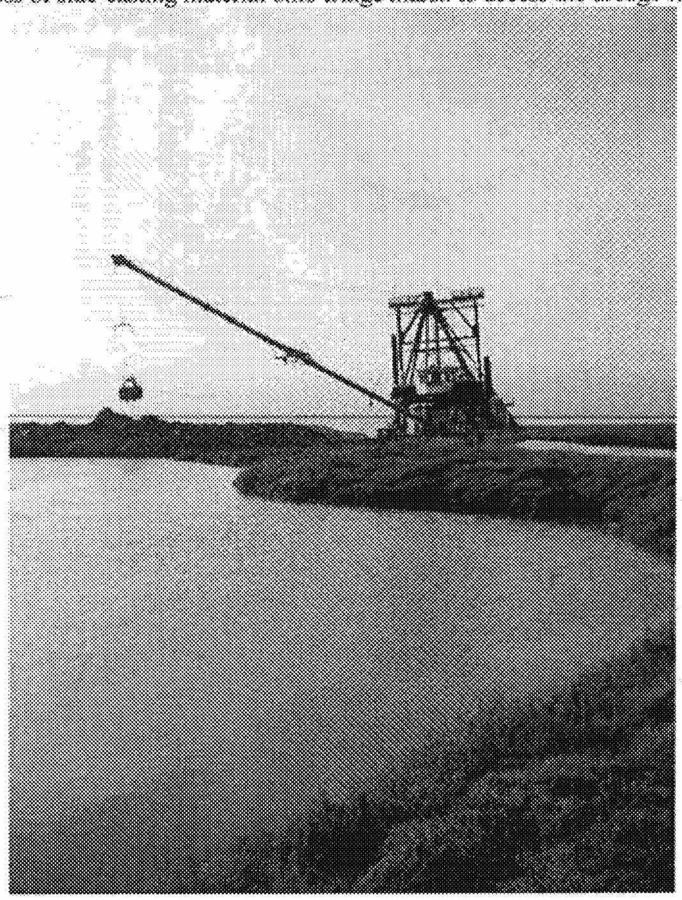


EXHIBIT 6

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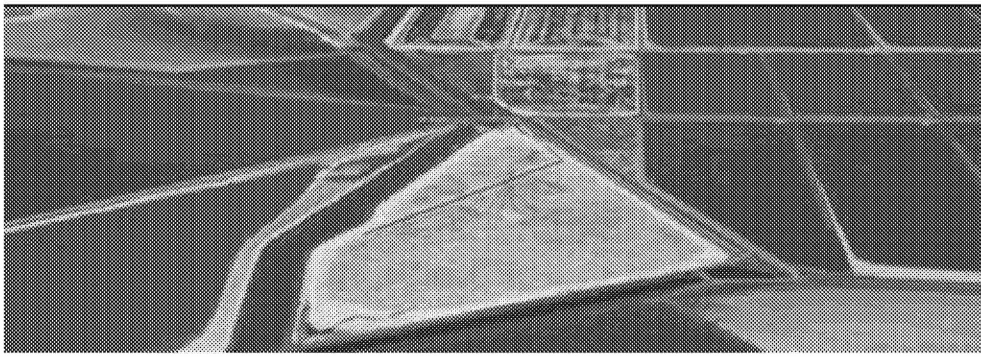


Solar ponds

Salt ponds

The San Francisco Bay Area boasts one of only two sea salt works in the entire United States. It is an ideal area for salt making, thanks to clay soils and a Mediterranean climate - just enough rain in the fall, winter and spring, followed by dry summers with steady breezes and plenty of summer sunshine.

First stop on the tour of our 12,000-acre operating system is the intake pond -- the beginning in a series of evaporation ponds (sometimes called evaporators, concentrators or concentration ponds). This is where we pump bay water into our pond system. San Francisco Bay water is only 71 percent as saline (salty) as sea water. (It contains 2.5 percent sodium chloride vs. the ocean's 3.5 percent.) Once inside our system, bay water begins its transformation into brine. Over five years, the brines will evaporate, concentrate and travel several miles before eventually yielding pure salt crystals.

The intake pond, like all salt ponds, is surrounded by levees, or walls of dirt that separate it from the Bay and other ponds. These levees, which trace original shoreline and early property lines, have shaped our baylands for more than 100 years. Most were built in the late 1800s to reclaim marshland for agriculture and then salt-making. Today, they're maintained by our wooden dredge, the Mallard II.

Mallard II

Mallard II has plied San Francisco Bay's salt ponds since her keel was laid in 1936. The crew of *Mallard II* works year-round, maintaining about 10 miles of the 80 mile levee system each year. The one notable exception: when *Mallard II* heeded the nation's call during World War II, retrieving artillery shells from the Bay floor around Mare Island and Port Chicago.

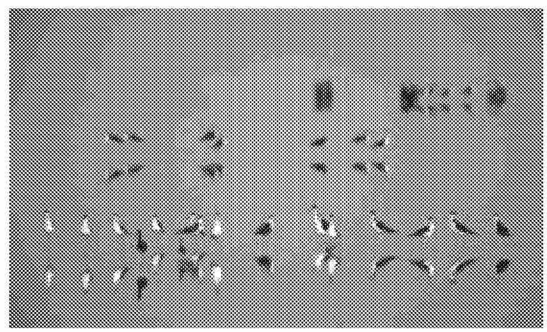
Anchored on her spuds, or stabilizing legs, the dredge scoops up mud from a borrow ditch to place atop the levee. She's remarkably fuel efficient - the Mallard II can operate for two months before refueling.

Mallard II is typically accompanied by a flock of birds that flutter and circle overhead, eager for the tasty fish and other food brought up with each bucketful of mud.

Mallard II helps maintain a network of gates, pumps and siphons to move water from the salt concentrator ponds to the evaporation ponds.

Evaporation ponds

Roughly 8,000 acres along the South San Francisco Bay are devoted to salt evaporation ponds – and all of this land is protected by the Don Edwards San Francisco Bay National Wildlife Refuge url:<> . Evaporation ponds (and the marshes that surround them) provide important habitat for more than 70 species of birds, including several endangered species. Because the ponds are shallow - an average of 1.5 feet deep - it's easy for shorebirds and waterfowl to find a meal in the low- and mid-salinity ponds.



Flying over the bay or driving over some of the area's bridges, you will notice that evaporation ponds have distinctive colors: beautiful green and red hues, colored by the microorganisms that thrive at varying salinity levels. Learn more about the unique salt pond colors url:<http://idocsna3.cargill.com/cargillcom/corporate-responsibility/environmental-sustainability/innovations-case-studies/san-francisco-bay-salt/sustainable-salt-making/salt-pond-colors/index.jsp?ssSourceSiteId=CSEG_SALT> .

As the sun and wind evaporate water from the brines, they get saltier. The saltiest brines are moved to crystallizers within our industrial plant sites.

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EXHIBIT 7

Waterbird Counts in Select Redwood City Saltworks Ponds 2009 - 2015

Observations made beginning December 2009 through April 2015 by Matthew Leddy. Only ponds observable from adjacent public access were included. Birds may use other ponds in the complex, but those ponds could not be observed. Counts were determined both in the field and with the aid of photos. Notes: * birds observed foraging, † birds observed on pond levee only, †† nesting in pond.

SUMMARY TABLE

Pond (Date observations began)	Shorebird species	Other waterbird species	Highest waterbird count (and date)
Pond 10 (12/22/09)	Willet*, Marbled Godwit*, American Avocet*, Black-necked Stilt*, Whimbrel, Long-billed Dowitcher, dowitcher species*, Dunlin*, Western Sandpiper*, Least Sandpiper*, Greater Yellowlegs*,yellowlegs species*, Semipalmated Plover*, and Killdeer††	Great Egret †, Forster's Tern, Canada Goose, Northern Shoveler*, Bufflehead*, Greater Scaup*, Lesser Scaup*, Common Goldeneye*, Gulls	8,115 (4/5/13)
Crystallizer Pond 1 (11/27/10)	Semipalmated Plover*, American Avocet*, Black-necked Stilt*, Dunlin*, Western Sandpiper*, Least Sandpiper*, and Killdeer†	Red-throated Loon, Northern Shoveler, Gulls*	3,814 (11/3/14)
Crystallizer Pond 2 (12/16/10)	Semipalmated Plover, Black-bellied Plover*, American Avocet*, Dunlin*, Western Sandpiper* and Least Sandpiper*	Gulls*	1,700 (12/9/14)
Crystallizer Pond 3 (10/7/11)	Black-necked Stilt*, Black-bellied Plover*, Willet*, Least Sandpiper*, and small shorebirds (one or more *Calidris* species)*	Lesser Scaup, Gulls*	349 (2/18/15)
Pond 7B (1/11/10)	Semipalmated Plover, Black-bellied Plover*, American Avocet*, Black-necked Stilt*, Killdeer†, Willet*, Dunlin*, yellowlegs species *, Least Sandpiper*, Western Sandpiper	Bufflehead*, Common Goldeneye*, Gulls*	3700 (12/4/14)
Pond 7C (1/11/10)	Semipalmated Plover, American Avocet*, Black-necked Stilt*,Willet*, Least Sandpiper*, Black-bellied Plover†, and Killdeer†	Canada Goose, American Widgeon, Bufflehead, Common Goldeneye	1,031 (2/18/15)

Contact information: mtleddy@sbcglobal.net

EXHIBIT 8

A GEOGRAPHIC HISTORY OF

SAN LORENZO CREEK WATERSHED

LANDSCAPE PATTERNS UNDERLYING HUMAN ACTIVITIES

IN THE

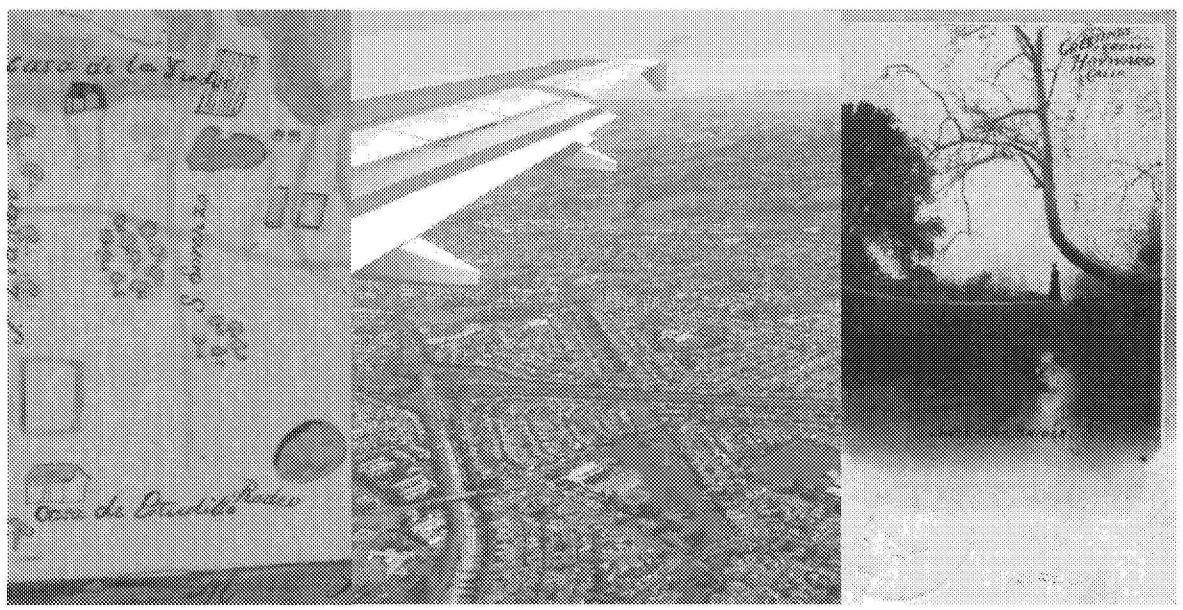
LANDS OF THE YRGIN

MISSION SAN JOSE RANCHO, 1796-1834

SAN LEANDRO, SAN LORENZO, AND SAN RAMON RANCHOS, 1830s-1849

TOWNS OF HAYWARD'S, SQUATTERSVILLE, AND MT EDEN, 1850s

CITIES OF HAYWARD, SAN LORENZO, AND CASTRO VALLEY

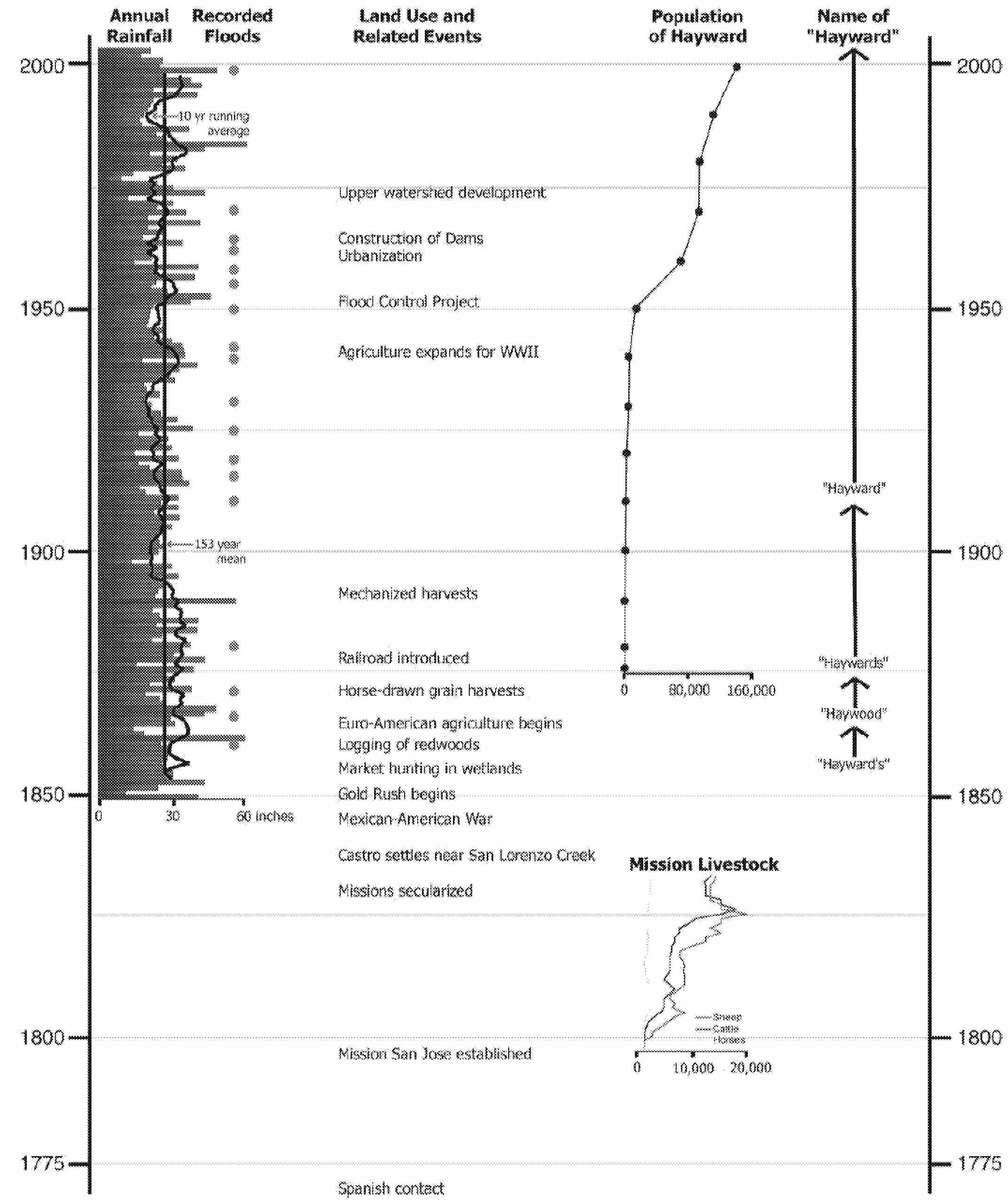


Robin Grossinger and Elise Brewster

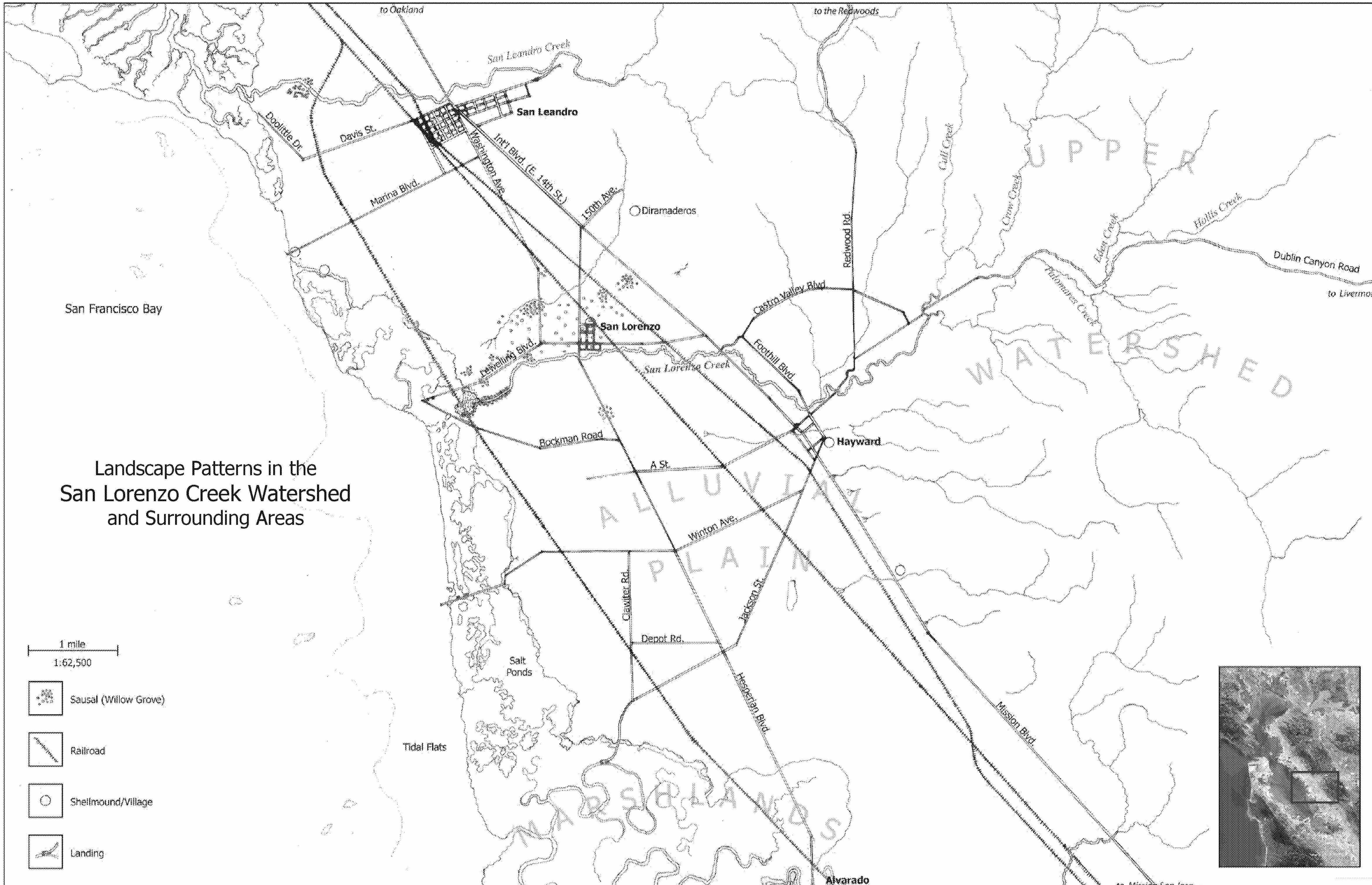
San Francisco Estuary Institute Regional Watershed Program

Prepared for the Alameda County Flood Control and Water Conservation District
Clean Water Program

SFEI Contribution 85
December 2003



Some agents of change in the San Lorenzo Creek watershed, 1769-2003. Rainfall data (July-June year) compiled by Lester McKee from Hayward data, using correlation to early San Francisco rainfall records that were developed by Jan Null (ggweather.com). Local flooding data from FEMA 1986 and Modrell (pers. comm.). Mission livestock data from Jackson 1994. Population data from Eden Writers 1975.



Landscape Patterns in the
San Lorenzo Creek Watershed
and Surrounding Areas
to Oakland
to the Redwoods
San Leandro Creek
San Leandro
Doolittle Dr.
Davis St.
Washington Ave.
Int'l Blvd. (E. 14th St.)
Marina Blvd.
150th Ave.
Diramaderos
Redwood Rd.
Cull Creek
Crow Creek
Hollis Creek
Eden Creek
Dublin Canyon Road
to Livermore
Palomares Creek
UPPER WATERSHED
San Francisco Bay
Castro Valley Blvd.
San Lorenzo
Lewelling Blvd.
San Lorenzo Creek
Foothill Blvd.
Bockman Road
Hayward
A St.
ALLUVIAL PLAIN
Winton Ave.
Clawiter Rd.
Jackson St.
Depot Rd.
Salt Ponds
Hesperian Blvd.
Mission Blvd.
Tidal Flats
MARSHLANDS
Alvarado
to Mission San Jose
1 mile
1:62,500
Sausal (Willow Grove)
Railroad
Shellmound/Village
Landing

Table of Contents

This report should be cited as:

Grossinger, R. and Brewster, E. 2003. A Geographic History of the San Lorenzo Creek Watershed: Landscape Patterns Underlying Human Activities. Prepared for the Alameda County Clean Water Program. A Technical Report of the Regional Watershed Program, SFEI Contribution 85. San Francisco Estuary Institute, Oakland CA. 23pp. plus foldout map.

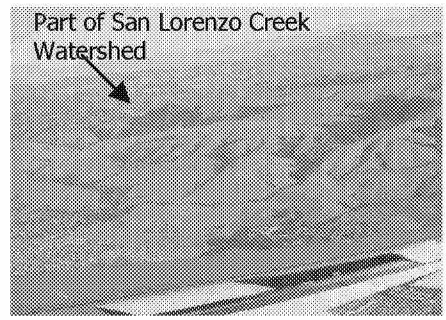
Opposite page: Map drawn by Elise Brewster; USGS Landsat 7 Image (2001) courtesy of the Center for Land Use Interpretation and SATimaging

This report investigates the historical characteristics of San Lorenzo Creek, a stream in Alameda County, CA, on the east shore of San Francisco Bay. The report documents the recent history of cultural and physical transformation, while describing the distinctive geographic patterns that continue to define places and guide human activities in the area. These ecological and geological features persist to varying degrees, despite substantial modification and relative obscurity.

The report is organized around these geographic elements, with each section corresponding to features on the foldout map.

San Lorenzo Creek Watershed

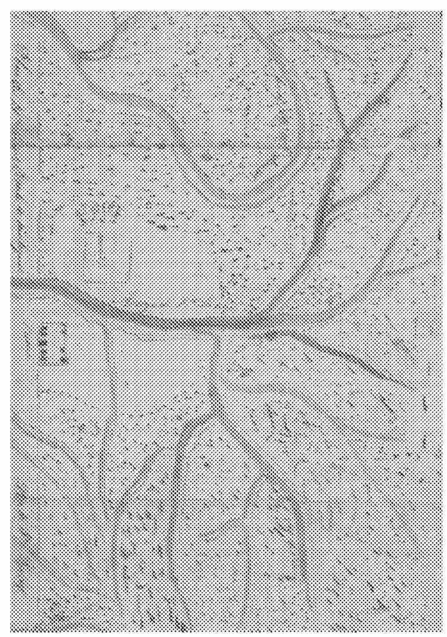
The San Lorenzo Creek Watershed drains 48 square miles of the portion of California's Coast Ranges locally referred to as the East Bay Hills. The creek flows almost due west from these hills towards San Francisco Bay, entering near the Bay's broadest part, directly across from South San Francisco.



East Bay Hills looking northeast towards Mt. Diablo (Alaska Airlines approach to Oakland Int'l Airport, November 2003).

The upper watershed includes eight perennial tributaries, which join to form the larger creek we call San Lorenzo. These small creeks are arranged in a fan-shaped pattern, with the three largest — Crow Creek, Cull Creek, and Palomares Creek — meeting within 2 miles of each other. They then flow generally west as San Lorenzo Creek, through a nearly enclosed valley named for the first Mexican landowner (Castro Valley), and through a break in the hills onto the bayside alluvial plain.

The canyons of this west side of the East Bay Hills form dozens of small streams that gather waters in the hills and spill out onto the flatlands bordering the Bay. But only a few of these were supplied with enough water to carve continuous, incised channels across the broad plain to tidal waters. In the southern part of the early East Bay — the 25 mile alluvial plain from the great Oak Grove of Oakland to the southernmost tip of the Bay — only two creeks traversed the flatlands with distinct, formidable-to-cross stream channels: San Leandro and Alameda.


The *Plan de San Lorenzo* (ca. 1840) accompanied Castro's land grant request. It effectively captures the branching pattern of tributaries forming Arroyo de San Lorenzo, and the proximity of San Leandro Creek before it curves to the north (upper center).

A third stream, San Lorenzo Creek, maintained a substantial channel across nearly the full width of the plain, before spreading out into the marshes alongside the Bay. These three creeks reached beyond the front faces of the hills into their internal canyons and valleys to create sizable watersheds with distinct channels — streams of major ecological and cultural significance.

San Lorenzo Creek

The first recorded description of San Lorenzo Creek comes from an entry on November 27, 1770 in the journal of Lt. Pedro Fages. Translated by Dr. Alan Brown in the 1960s, from a text published by the historian Herbert Bolton in 1911, the account records the first full Spanish expedition through the East Bay (a smaller scouting team reached as far as San Leandro Creek in 1769). We would expect the details of San Lorenzo Creek to be well observed, as they camped overnight on its banks:

"... we crossed a creek with a good amount of water, all overgrown with sycamores, laurels and other trees unknown to us, and stopped on a flat next to it." (Stanger and Brown 1969: 119)

Sixteen months later, on March 25, 1772, Father Juan Crespi describes the creek, which served again as campsite on this second expedition led by Fages. Crespi confirms its relative size and substantial riparian canopy:

"... we halted on the bank of a large arroyo close to the mountains skirting the broad plain. The bed of the arroyo is very full of alders, cottonwoods, and willows." (Bolton 1927: 287).

A half-century later, a Mexican diseño, or sketch (right), fills in the general picture. It shows a continuous but narrow riparian tree canopy marking the creek's location along the plain.

Further details about the creek emerge from later documents of Euro-American colonization. It is clear that San Lorenzo Creek provided a locally significant, unusually reliable source of water for people, livestock, and crops. San Leandro Creek (redwood forests in its upper watershed; currently supplies large reservoirs) or Alameda Creek (watershed size 10 times San Lorenzo) might be expected to have provided the more valuable local water supplies during early Euro-American development. But, although these two streams play much more significant roles in modern water management, San Lorenzo was the more important historical water source, prior to dams, diversions, and groundwater pumping.

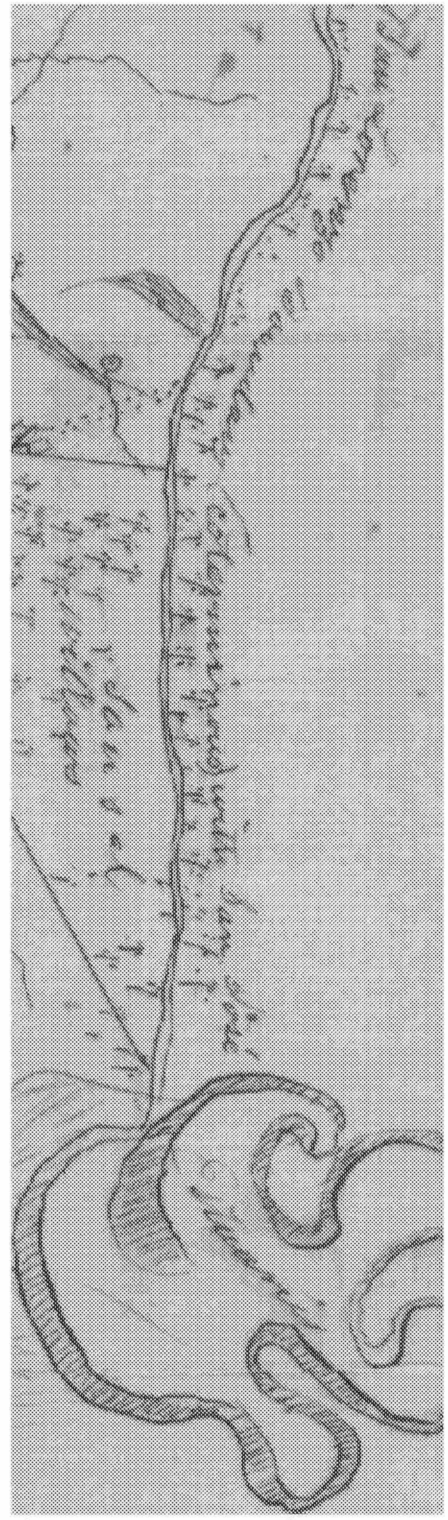
This characteristic led to San Lorenzo Creek's central role in the Mission San Jose Rancho (despite the creek's location more than three-quarters of the way from the Rancho boundary). The creek was noted by Father Duran in the 1820s, as part of a description of the Mission territory, which extended from the Santa Clara-Alameda County line to San Leandro Creek:

"Mission cattle both large and small feed on this corridor and through its center, some fourteen miles from the mission, flows the San Lorenzo Creek, the only abundant and permanent supply of water in the stretch. On its banks lies a mission rancho." (McCarthy 1958: 182)

Later, the position of the two most important local American towns, Hayward and San Lorenzo, would be influenced by the creek's route.

San Lorenzo Creek was also characterized by the extreme seasonal changes typical of Mediterranean climates. Thirty years into American settlement, new residents were still coming to terms with this annual pattern. For example, the local newspaper described nearby Sulfur Creek (a much smaller creek just 1200 feet to the south of San Lorenzo at one point in downtown Hayward):

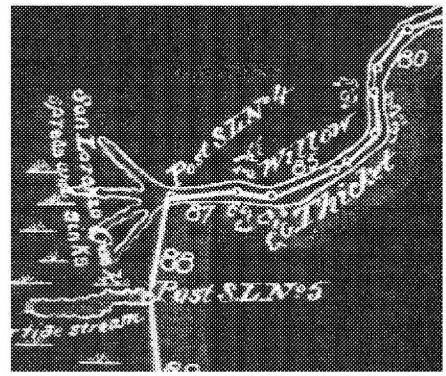
" ... the dry, insignificant ditch becomes a raging torrent sweeping out everything which impedes its way."



The *Plan of San Leandro* shows a riparian corridor along San Lorenzo Creek between the hills and the marshes ("Estuaries"), with their circuitous tidal sloughs. Courtesy of The Bancroft Library at UC Berkeley

San Lorenzo Creek was described as having uncontrollable flows every winter. Large debris routinely swept downstream, often washing out bridges (Sandoval 1991: 232-33, 235). This conflict with adjacent development eventually led to the construction of larger artificial channels and revetments to contain flood flows along the creek.

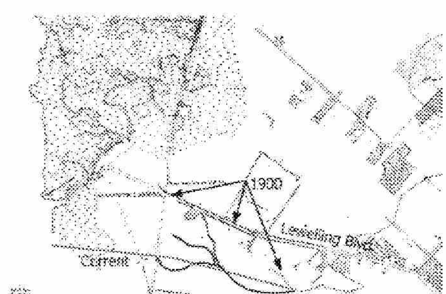
The stream supported a significant steelhead fishery, as indicated by 19th-century newspaper articles. For example, the *Hayward Daily Journal* reports in April 1885 that two fishermen caught 60 trout on the first day of the season, and in November, it notes the catch of a 14 pound salmon at the narrow gauge railroad crossing. One hundred and five trout were reportedly taken from the Palomares Creek tributary in a single day (Sandoval 1991: 279, 337). Local resident Steve Morris recalls a proclamation made by a local judge that "San Lorenzo Creek steelhead fishing is the finest in the world" (Modrell 2000).



The lowest reach of San Lorenzo Creek, depicted by La Croze (1858-63). Courtesy of The Bancroft Library at UC Berkeley

Although the creek was relatively well supplied with summer base flow and maintained a channel across most of the alluvial plain, it appears to have terminated or spread out before reaching the tidal marshes and Bay. The first map showing fluvial features in the area, by Capt. Beechey in 1827-8, does not depict San Lorenzo Creek at all, presumably because it was not visible as a channel through the marshlands. The first detailed, professionally-produced local maps (by the US Coast Survey (USCS) in 1857, and La Croze in 1858-63) each suggest that the creek spread into a distributary system encompassing freshwater marsh and sausals (willow groves) at the edge of the tidal marsh, and spread broadly across the marsh plain. The land grant confirmation survey by La Croze shows this condition with a pictographic representation and the words "San Lorenzo Creek spreds [sic] and sinks."

Some aspects of this complex system may have been affected by cattle grazing during the previous fifty years. For example, willows may have colonized slightly higher ground created by increased sediment deposition along older distributaries (Collins, pers. comm.). However, it is likely that San Lorenzo Creek was only shallowly incised in its lower reaches at the time of European contact, spreading water and sediment over a broad area at the edge of the marsh during high flows.

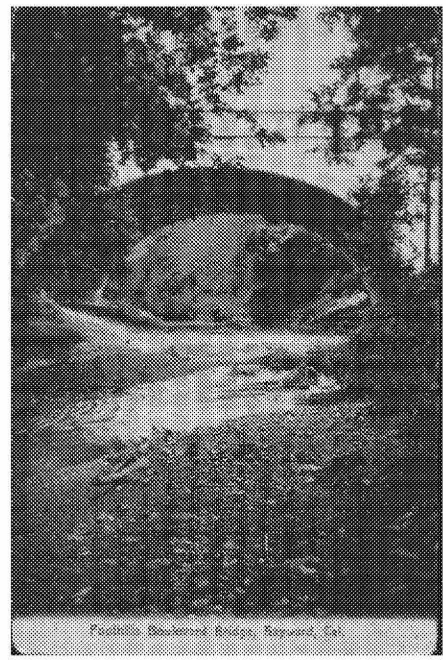


US Coast and Geodetic Survey 1900, with routes of prior and subsequent channels. The lower reach of San Lorenzo Creek has been extremely dynamic: multiple channels were shown in 1857 (see also p.6) and subsequent constructed channels have occupied completely different locations.

In 1900, the US Coast and Geodetic Survey (formerly USCS) carried out a "Resurvey." By this time, the lower reach of San Lorenzo Creek had been diverted north to run along Lewelling Boulevard below Farnsworth Street, more than a quarter-mile north of both its mid 19th-century and present-day routes. At this intermediate time, the stream, despite the redirection, was still shown as spreading diffusely into the marsh. The current flood control channel, which removed the creek from its lower floodplain and the tidal marshes, was constructed in the 1950s and early 1960s as part of a project that extended from the Bay to Foothill Boulevard.

The midsection of the creek (from the base of the hills to the Southern Pacific Railroad) has been mapped by a number of different surveyors since American statehood, resulting in different depictions. In general, most of these maps show a similar route across the plain. In particular, the most reliable early cartography of the channel — the surveys by the USCS and La Croze — shows similar patterns.

Another map, produced under State Geologist J.D. Whitney in 1873, shows a much more widely meandering stream. This map raises the possibility that the earlier maps are less detailed and that the stream straightened post-1873, perhaps in response to changing conditions of water, sediment, or bank vegetation. However, the close correspondence between surveys both before and after the Whitney map suggests that the differences in Whitney's depiction more likely reflect variation in mapping technique rather than on-the-ground changes. Additional data sources may further improve our understanding of the channel's evolution.



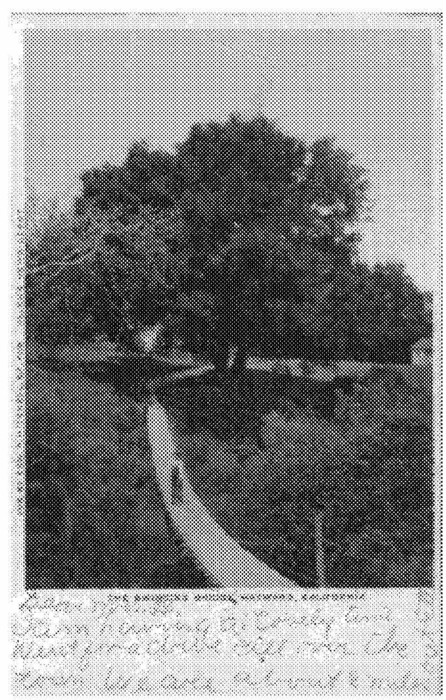
Early 20th-century tinted photograph of the stone bridge across San Lorenzo Creek at Foothill Boulevard. Courtesy of Paul Modrell and the Hayward Historical Society.

Alluvial Plain

The solid ground supporting the populous cities now surrounding San Lorenzo Creek was constructed by the creek and its neighboring streams. During larger storms, and prior to modern flood control projects, the creeks would overflow their channels, delivering sediment from the canyons out onto the flatlands, or alluvial plain. Over time, Bay Area streams built a broad river valley that has been filled by the rising seas over the past 10,000 years. At the time of European contact, only a thin strip of flat land remained between the hills and the line of high tide — about three miles at San Lorenzo Creek — to support most of the activities of human inhabitation.

Evidence of earlier characteristics of the alluvial plain is provided by historical accounts. For example, in late March of 1776, Font, on the third Spanish expedition through the East Bay, describes the plain in the vicinity of San Lorenzo Creek as lush but empty of trees:

> "All the rest of the road is through very level country, green and flower-covered all the way to the estuary, but with no other timber or firewood than that afforded by the trees in the arroyos which we encountered, which were five." (Bolton 1933: 356-357)



The "Swinging Bridge" near downtown Hayward. Courtesy of Paul Modrell and the Hayward Historical Society.

One of the greatest changes in the East Bay is the creation of a new urban forest where trees were once rare outside of the unique "Oakland" and the immediate environs of larger creeks. The replacement of the native grasslands removed major food sources from the indigenous landscape, particularly native grains and the onion-like bulb *amole*, "in which those plains greatly abound" (Bolton 1933: 357).

On this grassy plain, the Spanish explorers describe encountering tule elk, which they initially mistook for cattle but, up closer, found to be "the size of an ox, and with horns like that of the deer, but so long that their tips were eight feet apart." The explorers do not mention waterfowl here, perhaps because they took the high road, avoiding the wetter parts of the plain. Descriptions of similar moist grasslands in other parts of the Bay Area, however, give some indication of the area's likely use by waterfowl:

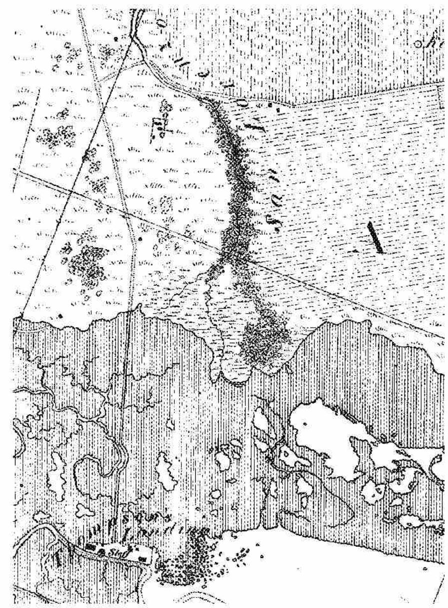
> Near Mission Dolores, Oct. 21, 1837: " . . . the plain is covered with flocks of wild geese in incredible numbers." (Simpkinson [1837] 1969: 7)

> Near Huichica Creek, adjacent to San Pablo Bay, circa 1870: "My father told of running through the fields when he was a boy, about 1868-1875 in April and May and having to be careful not to step on any of the myriad of baby ducks and geese rising from their feeding grounds . . ." (Duhig 1990: 2)

The open character of the alluvial plain was likely due substantially to native efforts. In the absence of repeated controlled burns carried out by indigenous Californians over many generations, it is probable that substantial areas that were open grassland at the time of European contact would have otherwise been vegetated by chaparral or woodland (Stewart 2001).

The Bay — Tidal Marshland

The relationship between San Lorenzo Creek and San Francisco Bay has substantially determined the watershed's human history. The edge of the Bay provided not only a set of abundant, easily available resources but also an efficient way to transport them to a major market, San Francisco. Bayside landings made agricultural products marketable and enabled transport of the nearby redwoods, whose location was itself due in large part to the moisture-providing coastal fog. The specific arrangement of these resources and points of access set many of the persistent routes of human movement.



San Lorenzo Creek spreads out as it approaches the marshlands and Thompson's Landing (USCS 1857).

The Bay was formed by the melting glaciers, which caused the world's seas to rise and spill into adjacent low-lying valleys. Initially, the rate of submergence was too rapid for extensive marshlands to take hold, but when sea level rise slowed, between 2000 and 3000 years ago, tidal mudflats and marshlands began to develop at the edges of the Bay. Because of its broad and shallow shape, the Bay/Delta developed extensive wetlands, comprising one-half of California's coastal wetlands circa 1850. Their ecological productivity, including shellfish, fish, waterfowl, tule reeds, salt, and other resources, supported the development of a large aboriginal population.

The marshlands near San Lorenzo Creek, and their abundant waterfowl, were actually the first local resources tapped by Americans, prior to agricultural and industrial development. During the Gold Rush, waterfowl from the Bayshore marshes brought high prices in San Francisco markets, leading to a lucrative trade. In the month of February 1852, for instance, Moses Wicks and Thomas Mulford sent the following quantities to San Francisco:

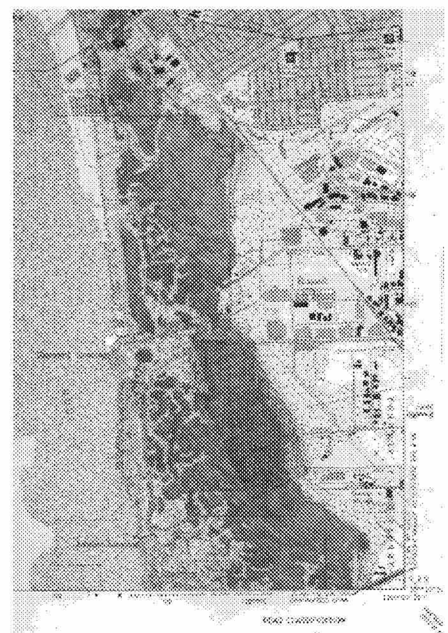
> "125 wild geese, 52 canvas-back ducks, 69 teal, 63 broad-bill ducks, 192 curlews, 207 plovers, 48 dowitches, 156 'peeks,' 48 snipe, and one rabbit." (Sandoval 1988: 43)

Initially drawn by the easy financial success of market hunting (on lands which could be construed as having dubious ownership), many of these market hunters soon developed salt ponds and freight landings on the sites of their hunting grounds. This relatively short-lived interest in wetland habitat, which nevertheless shaped the names and places of local economic development, would return to the region 150 years later, as part of environmental restoration efforts.

Salt Ponds

At its lower end, San Lorenzo Creek happened to intersect a unique feature of the Bay: the massive salt pond complex centered around Crystal Salt Pond. The feature appears to have been associated with a sandy berm built by wave action and may have been significantly managed and/or shaped by the indigenous Yrgin people.

Salt concentrated by evaporation from the broad, shallow ponds was harvested and traded by the Yrgin and later utilized by Mission San Jose. Other large salt ponds dominated the surrounding marshlands, including one that served as Castro's private salt pond, used for both cuisine and curing hides. Use of these ponds led directly to the extensive salt industry in San Francisco Bay, one of the few salt manufacturing processes based on passive solar evaporation in the world today. While there were natural salt pans in other parts of the South Bay marshlands, those near San Lorenzo and Alameda Creeks were of such large size that they led to extensive and rapid commercial development during the 1850s, generating American development in the area.



The shapes of Crystal Salt Pond, drawn over a modern USGS quadrangle. Elise Brewster 1994.

Following the Gold Rush, salt became particularly valuable and the ponds promised easy wealth. Local landings were established initially to transport the mineral products from these salt ponds, and only later used for distribution of agricultural products. The co-incidence of San Lorenzo Creek, the dividing line between two land grants (San Leandro and San Lorenzo Baja), with the salt ponds also meant that the marshlands were in uncertain and vulnerable ownership status.

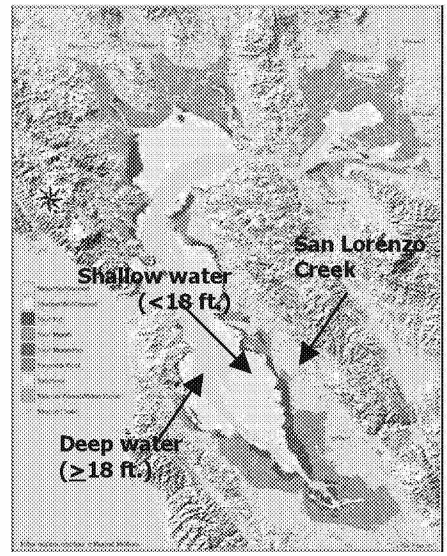
Because of their potential for salt production, these marshes were modified relatively rapidly compared to the rest of the South Bay. By the beginning of the 20th century, the few thousand acres of marshland between San Lorenzo Creek and Alvarado were extensively dissected by levees, ditches, and fences, while the rest of the 56,000 acres of South Bay tidal marshlands remained largely untouched. Even in these active areas, however, commercial salt farmers still largely used the original forms of the salt ponds during these decades. As a result, the overall acreage of ponds showed little increase, despite the modifications, until the 20th century.

Landings

While San Francisco Bay's expansive wetlands provided a wide range of valuable local resources, this characteristic of the shoreline conversely precluded convenient movement between the Bay and most of the surrounding land. Prior to reclamation, nearly half (47%) of the Bay was exposed at low tide, in the form of tidal flats and marshlands, and 80 percent was shallower than 18 feet below MLLW (Mean Lower Low Water). Even at high tide, only relatively small parts of the Bay reached as much as six feet deep — and that briefly — with a full third of the Bay still less than one foot deep and mostly unnavigable.

The twice-daily inflow and outflow of water through the intertidal habitats did, however, scour deeper tidal channels into the marshes and mudflats.

Most of these channels branched into progressively smaller dead-end sloughs, but a few reached further towards the shore, in some cases connecting directly to freshwater creeks. Points of commerce often developed where these sinuous marsh sloughs met the fertile valleys, effectively extending tidal waters inland, where they were bordered by dry land rather than soft marsh. Towns such as Alvarado, Alviso, Redwood City, Petaluma, Napa, and Fairfield thus became entry points to these narrow but navigable corridors through the otherwise impassible marshlands.

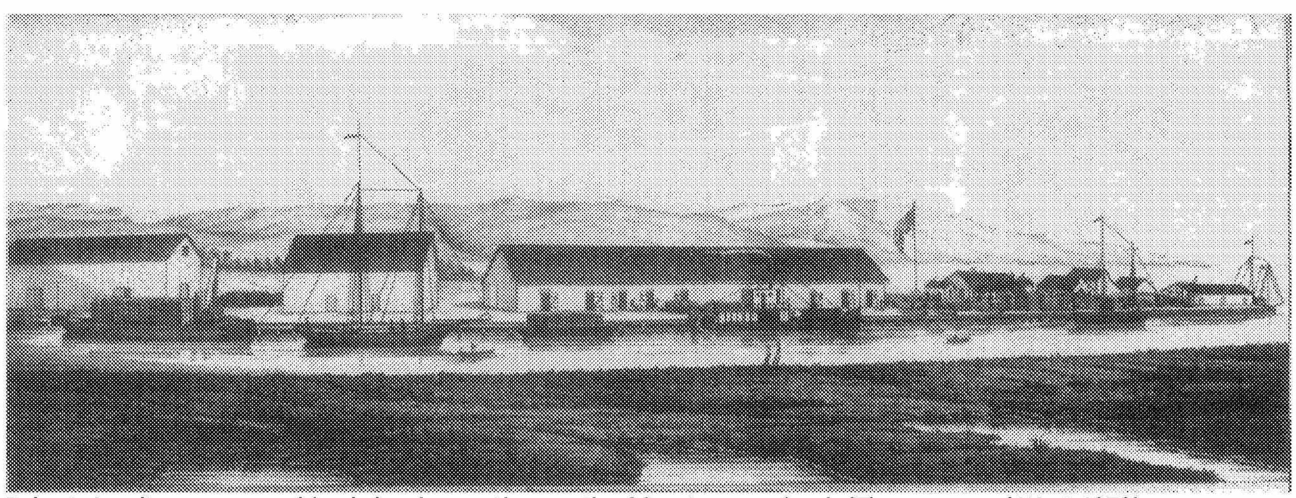


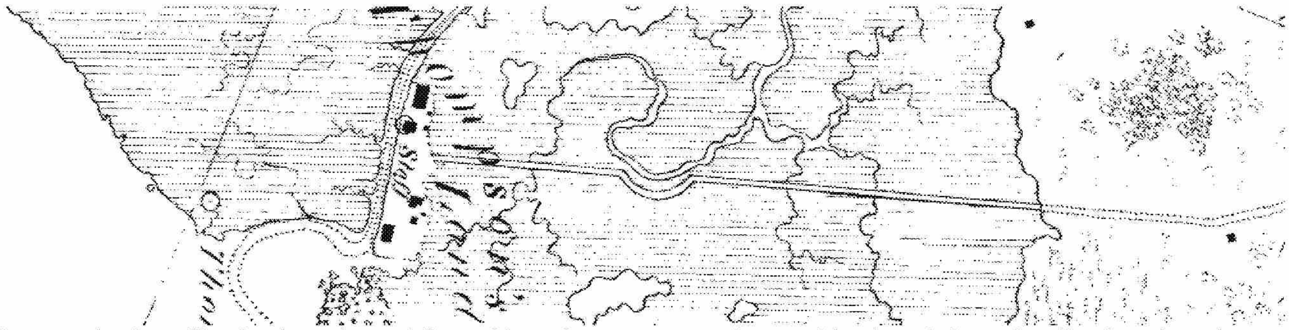
SFEI Historical View of the Baylands shows the relationship between San Lorenzo Creek and the Bay.

Another type of natural Bay landing occurred where steeper topography excluded marshes and mudflats, so that solid land directly intersected deep water. The general lack of such access along the East Bay shore necessitated the construction of the East Bay mole, a railroad wharf extending across the intertidal habitats to deeper water. When the proximity of deep water to dry land at Point Richmond was recognized in the late 1890s, it rapidly became a continental terminus for the railroad and an industrial center (see SFEI 2001).

In this geographic context, the San Lorenzo Creek shoreline presented a number of distinct and problematic characteristics with regard to aquatic transportation. The tidal marshland was narrow, but the adjacent mudflats were broad and continuous. The creek intersects San Francisco Bay at its widest point, where the deeper waters — navigable by larger boats and less limited by the tides — are particularly distant from the shoreline. As a result, the shoreline in the vicinity of San Lorenzo Creek was effectively about seven miles from fully navigable water.

Furthermore, the creek itself did not carve a channel into the marshlands, precluding the convenient link between tidal and fluvial channels, and any direct value of San Lorenzo Creek as a landing or port. Also, to a greater extent than in any other part of the Bay, the marshlands in this vicinity were dominated by large marsh ponds, rather than tidal channel networks. Without the channel systems to focus tidal water flow, there were few deeper water channels through the mudflats and shallow bay.


Roberts Landing, on a marshland slough near the mouth of San Lorenzo Creek (Thompson and West 1878).



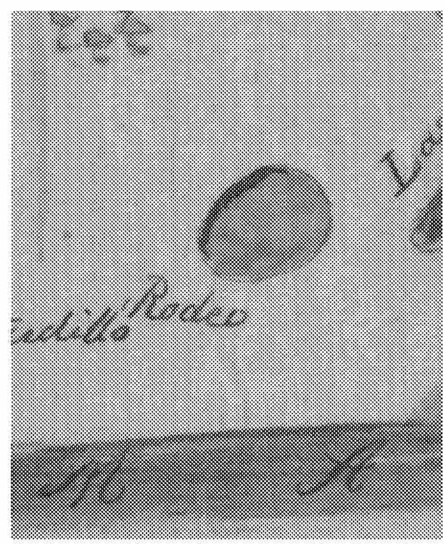
Present-day Lewelling Boulevard now follows this early route across the marshlands to Roberts Landing (purchased by William Roberts from Robert Thompson), except for the curve around a sinuous slough (USCS 1857).

Access to water transportation was nevertheless critical to the distribution and sale of local resources, so several effective sites were developed. The most important American landings were established by former market hunters and squatters on the two largest tidal sloughs in the vicinity— Roberts Landing to the north, and Mt. Eden Landing to the south. Roads were built across the marshlands to reach the edge of the slough, crossing smaller sloughs and avoiding larger ones. Mt. Eden Landing was successful largely because the mouth of Eden Slough was only 3.5 miles from deep water. But despite the fact that it was twice as far from deep water, Roberts Landing became "the great shipping point for all this valley and for the Livermore and San Ramon valleys also," (Sandoval 1988: 47) probably because it was the first to establish regular commercial schooner transportation to San Francisco. Some of the other important landings in the vicinity were Mulford's, at the gap in tidal marshland just north of San Lorenzo Creek and Hayward's, at the narrow point in the Crystal Salt Pond complex.

Mission San Jose — Rangeland

In 1796 the alluvial plain surrounding San Lorenzo Creek, from which the Yrgin had harvested grains and hunted wildlife for generations, became part of the Mission San Jose Rancho. Established 15 miles south of San Lorenzo Creek, Mission San Jose constitutes the first major European land use of the area, and a potentially significant early impact to the watershed. The Mission is also the initial center of European development of the southern East Bay.

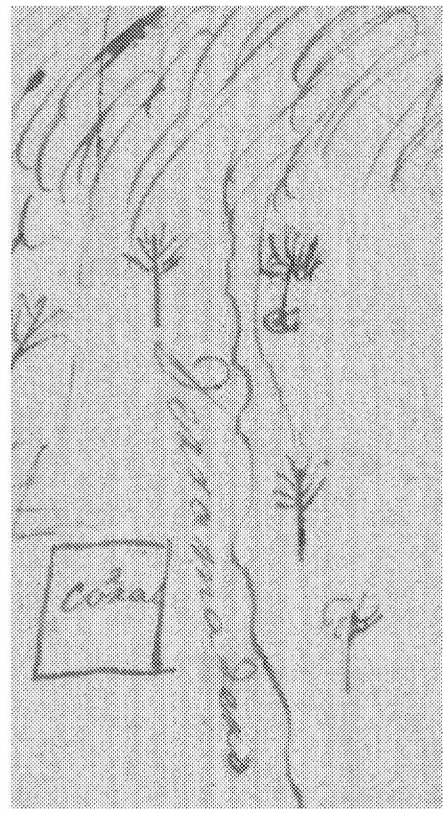
Upon its establishment, Mission San Jose received livestock from the neighboring missions in San Francisco, Santa Clara, and San Carlos. While several hundred cattle were apparently delivered, many of these must have been quickly consumed, as only 100 were reported in the annual tally at the end of that year. With no ability to deliver water, grazing lands were effectively excluded from the dry hills and limited to the East Bay plain (from the present day Alameda County/Santa Clara County line to San Leandro Creek) and the Livermore/San Ramon valleys to the east. The number of reported cattle remained below 1000 through 1803, but by the end of 1805 the herds exceeded 3000. By this time it is likely that cattle substantially occupied the lands along San Lorenzo Creek, particularly because of its importance as a water source.



Rodeo (cattle enclosure) on the Rancho San Lorenzo. Located on the lower part of the alluvial plain near the Bay ("*MAR*") in present-day Hayward. From the *Diseno de Rancho San Lorenzo*, courtesy of The Bancroft Library at UC Berkeley

In the winter, the herds were moved north through the San Ramon Valley into the valley oak savanna of the Walnut Creek Valley. This seasonal pattern of livestock rotation somewhat complicates the assessment of cattle density. For example, Father Duran characterizes Valle de San Jose (described above) in 1822 as providing summer pasturage for 9000 cattle and 10,000 sheep, but the annual reports for 1822 and 1823 list only 7000 cattle each year.

The use of pasturelands at greater distance, though, suggests that the East Bay plain was well-stocked, necessitating additional range. A general sense of the land use intensity during this time can be established by comparing reported livestock numbers (using the more conservative annual report values) with roughly corresponding areas. The area encompassed by the Mission San Jose East Bay rancho, as described by Duran (see p. 3), was approximately 50,000 acres. Combining the numbers of cattle and sheep (4-5 sheep requiring the acreage of one cow (Bancroft 1890: 55)), if all livestock were maintained here, by 1810 the density would have been approximately 6 1/2 acres per cow (6000 cattle and 7000 sheep; see inner cover). This is a fairly high stocking rate, as Bancroft cites standard cattle densities during the Mexican and early American eras of one cow per "5 acres of valley land," "10 acres on San Joaquin plains," and 7 acres "in the more humid coast counties of Humboldt and Mendocino."



The *Diseno de Rancho San Lorenzo* shows a creek emanating from the springs at "Deramadero," and a corral. Courtesy of The Bancroft Library at UC Berkeley

From these rough determinations, we can infer that pasturage would have been used fully by this time or soon after, and that the grazing density in the vicinity of San Lorenzo Creek, where livestock would have tended to concentrate for daily access to perennial water, would have been particularly high. Intensive European use of the San Lorenzo Creek area can thus probably be dated to 1805, by which time herds had rapidly expanded to 3,162 cattle and 8,000 sheep, for a combined rate of one "cow" in 10 acres for the overall East Bay area. Based on previous studies (SFEI 2001), we would expect to see effects upon sediment supply and runoff by about 1810.

Livestock levels continued to increase through the first decades of the 19th-century. Evidence of overgrazing was suggested by 1837, when 6000 head of cattle were moved to the Livermore Valley:

> "owing to the quantity of cattle on the Mission lands, feed is becoming scarce and they have died in considerable numbers of pure starvation."

After the secularization of the California missions in 1834, the lands around San Lorenzo Creek were granted by the Mexican government to several men — including Joaquin Estudillo (San Leandro), Guillermo Castro (San Lorenzo Alto), Francisco Soto (San Lorenzo Baja), and Jose Amador (San Ramon) — for the establishment of ranchos. During this period, grazing density may have reached even higher levels than during the Mission era. Some accounts put Castro's herd at 10,000–15,000 head in an area of less than 30,000 acres (a density of 1 cow/2-3 acres).

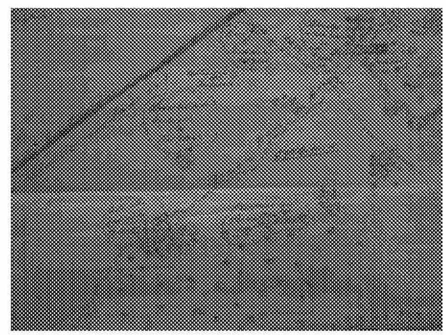
As the herds expanded into the Yrgin's lands during this period, the Yrgin themselves probably served as vaqueros, herding the cattle on lands that had been previously their own. The high human mortality rate at the mission necessitated continual recruitment of converts, often using force to cause relocation to the mission. After 1810, many of the converts brought to the mission each year were from the larger populations of the Central Valley, who became the new labor force for Mission system.

The relationship between native peoples and the land has typically been denigrated since European contact (e.g. "In this land of plenty they had scarcely wits enough to keep alive" (Stuart 1951)). Yet local tribes not only helped shape the open grassland ecosystem that facilitated the Spanish cattle-based economy, but also largely built the Mission landscape, as the primary source of labor for Mission activities. A rare recognition is found in a cemetery marker near Mission San Jose:

> "Here sleep Four Thousand of the Ohlone Tribe who helped the Padres build this Mission San Jose de Guadalupe. Sacred be their memory." (Stuart 1951: 39)

Diramaderos - Sausals - Indian Grant - San Lorenzo Grove

The Diramaderos, or "overflowing of the springs", was an array of mineral springs associated with the Hayward Fault. The springs produced a sizable flow (est. 3000 gallons of water per minute, ~6.7 cfs) that had a large zone of spatial influence. Early maps show stream channels extending from the springs across nearly the entire alluvial plain.

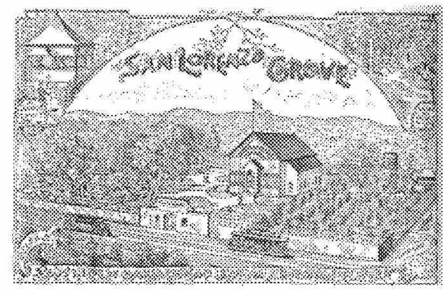


The survey by Gray shows native settlement in 1841/42. Courtesy of The Bancroft Library at UC Berkeley.

The spreading of these waters toward San Lorenzo Creek created an area between the spring channels and the creek that had an unusually high water table and supported extensive willow marshes, or "sausals." The sausals supplied native peoples with building materials and were likely managed, with techniques such as coppicing, to provide straight branches for arrows, baskets, and houses. The groves also provided shade on an open plain, shelter from the winds off the Bay, and probably contained smaller springs. In fact, the one native village in the area that was not associated with the Bay or the base of the hills was located in these groves, and later became downtown San Lorenzo. The water supplied by the Diramaderos may also have been partly responsible for San Lorenzo Creek's perennial flow along its lower reaches. The flowing of the springs at Diramaderos is said to have ended with the 1868 Hayward fault earthquake.

Some writers speculate that as many as 150 people lived in the native village at Diramaderos during the early 19th century, in a community that received unusual legal recognition from the Mexican government. As a condition of the grant to Estudillo, the Indians at the Diramaderos were granted the land "on the meadows" north of San Lorenzo Creek. These wet meadows and "overflow lands" were to be used by the Yrgin as a hunting and fishing preserve (Sandoval 1988: 43).

This stipulation was a rare instance of explicit transfer of lands to an Indian group in the Bay Area. It appears to have contributed to the general confusion regarding the boundary between Estudillo and Soto, making their claims more difficult to pursue in the American courts. Eventually both the Yrgin and the Mexican Rancheros lost ownership of the land to immigrant Americans. A map produced as part of these court cases, describing the area as of 1841/42, nevertheless shows "an agreed line between Estudillo and Indians" and areas explicitly used by Indians, including a corral, fields of wheat and "mellons [sic], corn and beans" (Gray 1855). The map provides a glimpse into an organized and extensive (> 1000 acres) Indian community persisting in the heart of the Bay Area through a half-century of Spanish occupation.



Drawing of the San Lorenzo Grove ("A Savory Spot"). The renowned willows can be seen to the left of the building (Eden Writers 1975).

The willow groves were also valued for a time in the American era. One was developed into a popular vacation spot. In 1893, the Hayward Journal described "The Picnic Paradise of California," proclaiming that:

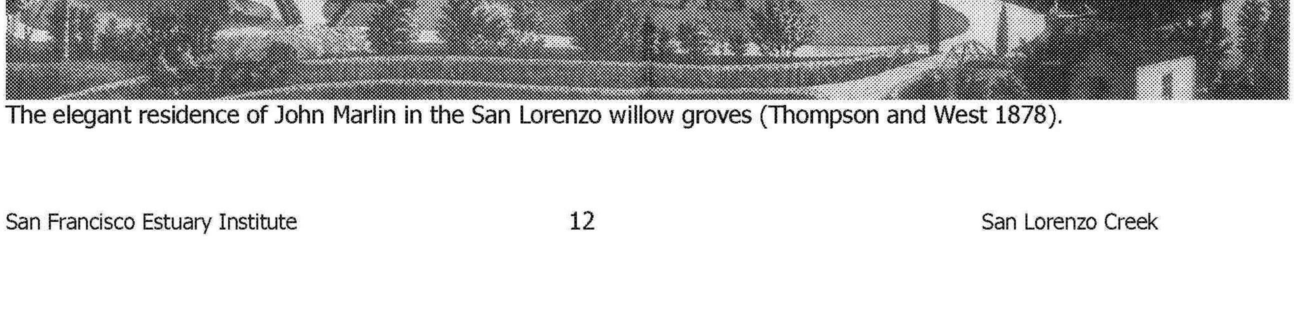
> "There is not a more beautiful picnic or pleasure resort on the coast than San Lorenzo Grove, situated in the charming village of San Lorenzo, on the line of the Oakland, San Leandro and Haywards Railway, owned by this company, who have spent a large amount of money in erecting a handsome and spacious pavilion and providing every accommodation for pleasure seekers. The electric cars run every half-hour to this grove . . ."

In striking contrast to current conceptions of willow marshes as unpleasant and mosquito-producing, these features were selected by leading citizens and molded into elegant gardens and homesites.

Towns

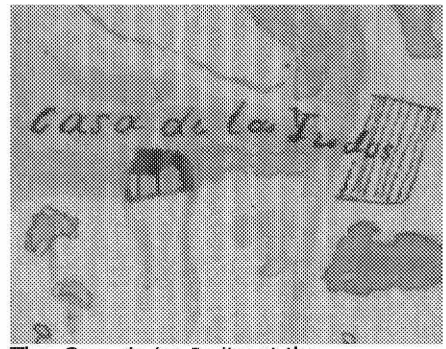
At the time of European contact, San Lorenzo Creek watershed was part of the lands of the Yrgin people. The Yrgin appear to have been closely related to their neighbors to the north, the Jalquin, who lived in the vicinity of San Leandro Creek and the Redwoods, and the Seunen, of the present San Ramon-Dublin area to the east. The Yrgins entered Mission San Jose primarily between 1799 and 1805, due to a variety of pressures, including aggressive missionary work, disease, and decreasing food supply.

In their initial contacts, the native people were generally peaceful in response to the newcomers. In an indicative description by Father Font, he reports that "[o]ne Indian who carried his provisions on the end of a pole invited us to eat some of them" (Bolton 1933: 357). In the vicinity of San Lorenzo Creek, Father Font describes the local language as "distinct from all those we had formerly heard," reflecting the cultural diversity of the Bay Area, which supported several dozen distinct tribes at the time of European contact (Milliken 1985).



The elegant residence of John Marlin in the San Lorenzo willow groves (Thompson and West 1878).

Studies of the Alameda Creek area, several miles to the south, and other parts of the Bay Area, suggest that indigenous residences shifted seasonally to utilize the resources available at different times of year. Because of the year-round availability of shellfish and other aquatic foods, however, tribes usually maintained some permanent presence in a village on the shores of the Bay. In the San Lorenzo area, the shellmounds located at the northern edge of the vast South Bay marshlands may have been such a village. During winter, migratory waterfowl were hunted in the marshes. During spring and summer, groups spread out to the collect bulbs, greens, and grass seeds from the alluvial plain. They developed base camps and brought materials back to the bayside village for winter storage. In summer and fall, the hills were utilized for hunting deer and the intensive gathering of acorns from groves of oak trees. Seasonal villages were associated with these activities.

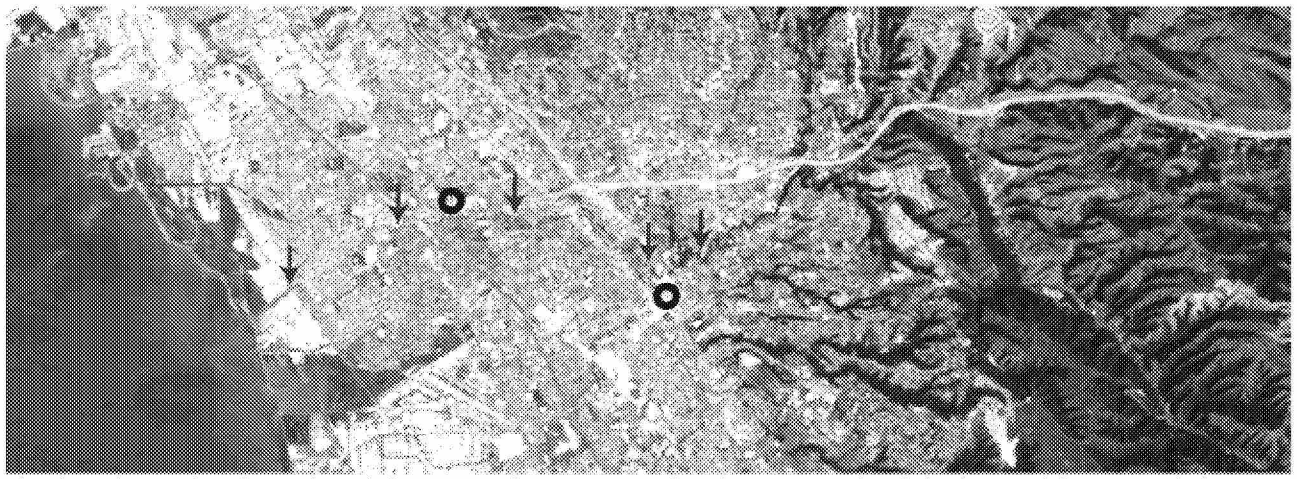

The *Casa de los Indios* at the Diramaderos. From the *Diseno de Rancho San Lorenzo*, courtesy of The Bancroft Library at UC Berkeley

Artifacts and historical information suggest that seasonal villages in the San Lorenzo Creek area were probably located at the Diramaderos springs, in downtown Hayward, in the vicinity of the San Lorenzo Cemetery, and at the Holy Sepulcher Cemetery. These summer and fall habitations are located at springs or creeks at the base of the hills that would provide water sources later into the year, or, in the case of downtown San Lorenzo, along the creek in the willow groves downstream of the large spring at Diramaderos. Miller suggests that the Hayward Civic Plaza was a key village site because San Lorenzo Creek provided the only perennial source of freshwater (1975: 10).

Most of the early Spanish and American town centers in the vicinity — including San Lorenzo, Hayward, Alvarado (numerous shellmounds), and Mission San Jose (the Indian village of Oroysom) — were established on native village sites, which had already been identified as the best spots for human settlement. In fact, some of these sites, such as San Lorenzo and Alvarado, had been physically constructed by indigenous communities. Shellmounds several stories high provided an elevated position above the valley floor, removed from floods, and often planted with buckeye trees for shade.

Despite persistent Indian presence in the vicinity, squatters such as Mulford and Roberts were able to establish an American settlement in the shellmounds and willow groves near the Bay during the 1850s. "Squattersville" became the town of San Lorenzo, well-positioned for access to the waterfowl and salt resources of the marshes, and a natural crossroads (leading to its other historical name: "Four Corners").

In 1839, Guillermo Castro took advantage of the shelter of the San Lorenzo Creek canyon mouth, near the creek and springs, and built a small adobe in what is now Hayward. Within a few years the Mexican government granted him the San Lorenzo Alto Rancho, which he operated from this location. A decade later, William Hayward established a store in tents among the oaks on land purchased from Castro, which soon became the major local institution, Hayward's Hotel.



The densely populated area (gray/white pattern) now surrounding San Lorenzo Creek (red arrows) has expanded from two towns established near its banks, Hayward and San Lorenzo (black circles). They were built upon the sites of previous Indian settlements.

As the town expanded around "Hayward's Place," it experienced a convoluted etymological evolution to arrive at its current name. When the local use of "Hayward's" was disallowed by the U.S. Postal Department because Hayward was a living person, town leaders came up with the creative solution of "Haywood." This name lasted for almost a decade until the town was officially chartered as "Haywards," without the apostrophe, and approved by the Postal Department. In 1911 the name was streamlined to Hayward.

Redwoods

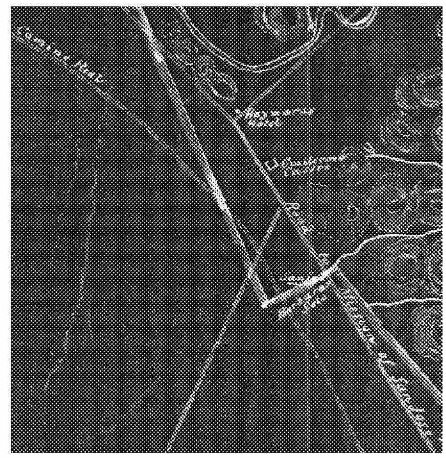
The redwoods in the canyons of neighboring San Leandro Creek represented a valuable, locally-rare building material — large, closely spaced trees with straight, durable, easy-to-work wood. The road from Castro Valley to the redwoods was an essential route to acquire lumber for both local use and distribution to San Francisco and other markets. As early as the Rancho era, Castro obtained lumber for his corral, barn, and fence posts from the redwood groves. Substantial deforestation did not take place, though, until the 1850s, when the tremendous growth of San Francisco during the Gold Rush necessitated large amounts of building material. Consumption was so rapid that most of the Oakland-San Leandro redwoods had been depleted by the end of the decade (Sandoval 1943-1944).

The old bridge across San Lorenzo Creek at Foothill Boulevard. Courtesy of Paul Modrell and the Hayward Historical Society.

Roads

When Europeans first explored the Bay Area, they generally didn't have to blaze trails through thick chaparral or tall grass. Rather, they followed the road — "el camino." The first Spanish expeditions commonly record "well-beaten paths," even in places where few native peoples were encountered (e.g. Bolton 1927: 285). Coming up the East Bay in 1776, Font comments that "the road is apart from the estuary, at first about a league and then farther and farther away" (Bolton 1933: 359) and "the road followed the foothills" (Bolton 1933: 361). Anza's diary from the same expedition summarizes the route near San Lorenzo Creek, also notes the grassland-covered hills, conspicuously lacking forest: "the road runs close to a small range completely bare of trees, for none are seen except some which grow in the canyons" (Bolton 1930: 135).

The roads encountered by the Spanish had been etched into the landscape through centuries of indigenous use, connecting villages or towns to local resources and more distant destinations. The Indian road described above linked the Santa Clara Valley with the Oakland area. With the assumption of control by the Spanish government, it became El Camino Real, the only continuous road along the East Bay plain in historical times. Present-day Mission Boulevard (East 14th St./International Blvd. in Oakland) largely follows the original Indian and subsequent Spanish road, but some adjustments were made. While the ancient and early historical roads tended to make adjustments for small hills and swales, modern roads reduce both vertical and lateral variation with road cuts and fill. Additionally, while earlier roads usually make perpendicular crossings at creek narrows (to minimize bridge length), larger modern bridges tend to be aligned for maximum linearity. While generally similar, the displacement of the straight modern route from the ancient route can be substantial.



1862 map shows the curve of El Camino Real, several hundred feet from the line of Mission Boulevard, near the crossroads at Hayward's Hotel (Stratton 1862).

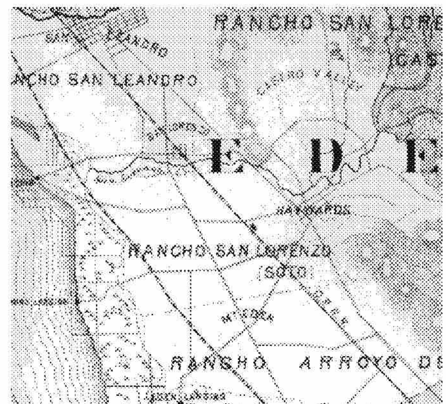
Despite these variations, many important modern roads generally follow ancient routes. Redwood Road carried felled trees from the neighboring San Leandro Creek watershed down through the less rugged Castro Valley. Marina Boulevard crossed the alluvial plain to Mulford Landing, the shellmounds, and a large salt pond. Similarly, Hesperian Boulevard split off from El Camino south of San Leandro to reach the important shellmounds, salt ponds, and landings on Alameda Creek at Alvarado.

From San Leandro, a second road along the plain splits from El Camino, becoming Washington Boulevard. Specifically constructed to transport redwood lumber from the forest to Roberts Landing, Washington turns towards the Bay as it approaches San Lorenzo, precluding a direct route between the two towns and creating a peculiar but persistent road pattern in that area.

Many of the other original roads radiated outwards from Hayward, ultimately shaping the region's geographic pattern. The town center of Hayward occupied a natural position as a crossroads between El Camino and the most convenient route through the hills to the lush Livermore Valley. This route through the canyons to the extensive freshwater marshes and willow groves that characterized Livermore Valley was also presumably used by the local tribes. As Livermore became an important area for ranching and agriculture, the road became a well-used route by Euro-Americans, from the private wooden plank toll road developed by Dougherty in the 1850s, along which his stagecoach line operated, to Dublin Canyon Road and Highway 580.

From the central, habitable location that became Hayward, roads extended across the plain to the three neighboring towns — San Leandro, Squattersville/San Lorenzo, and Alvarado — and to the major bayside landings. Thus Castro Valley Boulevard-Mattox Road-Lewelling Boulevard, A Street-Bockman Road, Winton Avenue, and Jackson Street connect the Hayward area to the many important sites along the Bay, in a roughly radial rather than orthogonal pattern. These destinations were also important sites of native activity, so these roads probably substantially follow indigenous routes.

These patterns reflect the greater significance of roads between the hills and the Bay through most of human history, when local resources were more important for local sustenance and economics. Today the dominant routes of transport and commute run parallel to the Bay, and through the canyons to the interior valleys of the county. Roads angling across the alluvial plain — the routes for gathering salt, bringing acorns to bayside villages, visiting waterfowl hunting sites, launching tule canoes for Bay fishing and transport, carting grain and redwoods to Bay schooners — have become less important. The intersection of the more angular transverse routes with the parallel routes along the plain has created an idiosyncratic local street pattern, with a preponderance of irregularly-shaped plots and major streets which do not directly connect.



Early roads in the vicinity of San Lorenzo Creek (Haynes 1878).

The street grids that dominate the present-day landscape are, for the most part, established within these large triangular and trapezoidal shapes created by the ancient road network. For example, the newer streets Research Road, Trust Way, and Investment Boulevard subdivide land bounded by the older Jackson Street and Eden Landing Road.

Dense internal patterns have been developed to allow intensive access to parcels within this framework and a supra-transportation system of railroads and freeways created for frequent travel over longer distances. However, the organizational system of the area is still largely structured by springs, sloughs, and redwoods now non-existent or hidden away. A "destinational" system developed to connect naturally distinctive local places has become the organizational system for a more homogenous use of the landscape. Interestingly, Bay-to-Hills trails proposed for local creeks may re-establish some of the cultural importance of these historical routes.


Diagonal street patterns in Hayward reflect relationships between natural landscape features.

Railroads

The first railroad across San Lorenzo Creek was a local railroad between Alameda and Hayward that began operation in 1865. The line was designed to transport local agricultural and industrial products and to deliver clients to the spa-hotel at Warm Springs. Its conception aroused great fanfare and boosted the growth of Hayward, but damage from the 1868 earthquake and the completion of the juggernaut transcontinental railroad led to its demise. The *Alameda and Haywards* tracks never reached Warm Springs and were torn up in 1873.

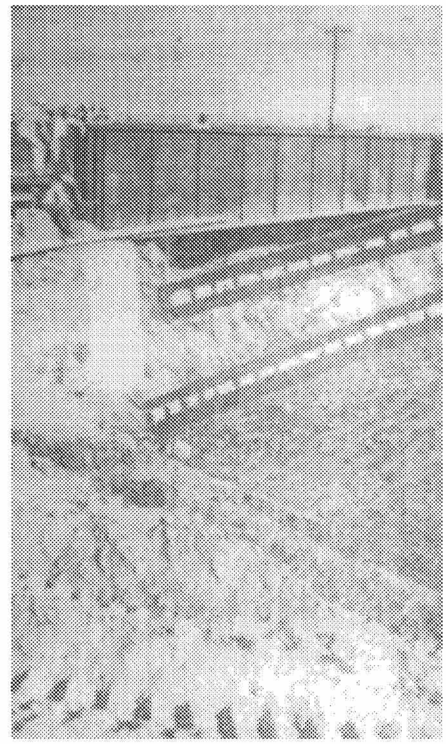
In 1869, the transcontinental Western Pacific Railroad, paralleling and superseding the earlier railroad, came through Niles Canyon to Hayward, connecting Oakland to the East Coast of the United States. The new railroad initiated the decline of the commercial landings, particularly with the establishment of the South Pacific Railroad in 1878 immediately adjacent to, and in places, through the marshlands.

Farmland

Following the acquisition of California by the United States in 1848 through the Mexican-American war, the lands surrounding San Lorenzo Creek were rapidly transformed into farmland. Despite the previous half-century of grazing and associated ecological changes, the gentle underlying topography of the San Lorenzo Creek alluvial fan still offered remarkable fertility to American squatters and settlers. Future city namesakes Hayward and Meeks described the incredible height of wild oats and mustard (20 ft tall!), both referring to non-native species advancing in a changing landscape in the early 1850s. The common seasonal flooding that had produced these rich soils still continued alongside American development for a full century, until the construction of the major flood control projects of the 1950s.

Agricultural ventures grew rapidly in the second half of the 19th-century, associated with the disintegration of the massive Mexican land grants. Smaller plots were sold off by Castro and others to raise cash for the legal costs of proving title in the American courts. These parcels were developed into farms by immigrants such as Meeks and Lleweling, who established the political and economic framework that evolved into the present-day cities. Locally produced potatoes, grain, hay, fruit, and vegetables from these farms were transported to the rest of the Bay Area through the landings.

By 1864, Meek's orchards employed 100 people and used an irrigation reservoir in the foothills 3 1/2 miles away (Sandoval 1943-44: 326). Four years later, the orchards included 20,000 almond trees, 3,000 plum trees, and 32,000 currant bushes (Stuart 1951; Sandoval 1943-44: 327). Agricultural production in the area surrounding San Lorenzo Creek continued to be the dominant use of the land through World War II and into the 1950s.



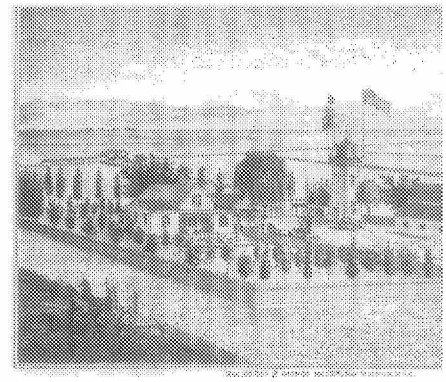
"SCOOP . . . Huge shovels began scooping out the dirt near the mouth of San Lorenzo Creek this week. Photo shows present three-foot depth of creek bed under a Southern Pacific railroad bridge. Second dotted line shows 11-foot depth to which the Creek will be dredged under the bridge." (Original caption in the Daily Review, 1954; courtesy of Hayward Historical Society)

Canyons

Spatially removed from the more intensive cultural development of the alluvial plain, the canyons tributary to San Lorenzo Creek nevertheless have experienced a dramatic land use history. By contributing water and sediment to the creek, they also contribute fundamentally to characteristics downstream.

While the canyons comprising the upper watershed of San Lorenzo Creek were too dry to support grand redwood forests, they were surprisingly lush a century ago. In her memoirs, Amy Jensen (1892-1977) of the Jensen Ranch family describes the Eden Canyon of her childhood, recalling that "[t]he banks [of the stream] on either side were covered with maiden-hair and sword ferns and lace flowers and hair bells and other lovely flowers in between." She recounts wildflowers in detail: "the lovely fields of lupines, poppies, cream cups, butter cups, wild hollyhocks and the delicate wind poppies . . . are all gone." Jensen ascribes these changes to "the cattle and sheep [that] have roamed the hills and dells and nibbled busily away at everything green" (Jensen 1999).

European use of the canyons initially focused on cattle grazing. Castro established herders' camps at the mouths of each canyon, while using the adjacent Castro Valley for summer fattening. Americans quickly established agricultural practices in the canyons, despite steep hillsides that made plowing and harvest challenging. Barley, oats, and hay were put in using single horse-drawn plows, wooden binders, and bundle wagons. More mechanized equipment appeared in the latter part of the 19th century (including traction engine harvesters weighing as much as 11 tons, introduced in the 1880s) and diversified crops were developed. Fred Jensen recollects prunes, apricots, plums, and almonds, an entire hillside of peas, olive trees mixed "among the oaks and brush," and 400 tons of tomatoes (Jensen 1993).



Grain harvest depicted as part of a farm scene in the *Official Historical Atlas Map of Alameda County* (Thompson and West 1878).

In the mid part of the 20th century, after nearly a century of agriculture in the canyons, most farming operations reverted to sheep and cattle grazing — an unusually circular pattern of development. Fred Jensen looked back upon this history in 1965:

> "As time went on and circumstances changed, the Ranch was leased and sheep do most of the harvesting now. Maybe an easier way to do it." (Jensen 1993)

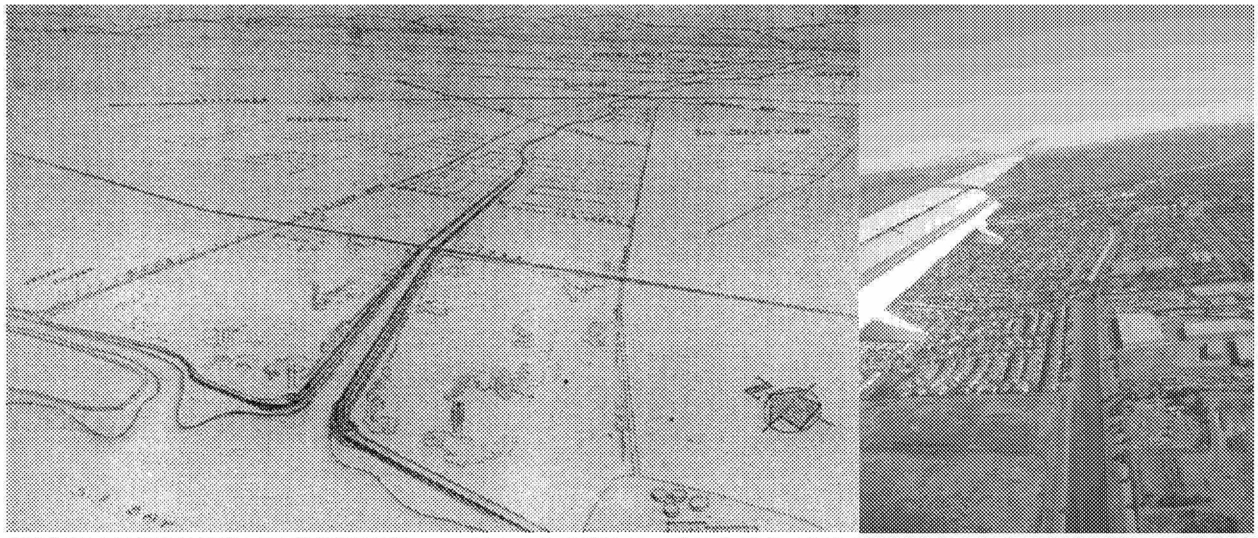
In more recent decades, suburban development has expanded into some parts of the canyons. The Euro-American transformations of the canyons — from grazing to agriculture to grazing to residential development — have modified how the canyons function as part of the watershed. Some of these effects include the replacement of native hillside vegetation with plants more tolerant of intensive grazing, increased exposure of soils to erosion, and more rapid runoff following storms (Collins, pers. comm.). Greater delivery of sediment and water to the stream has likely decreased the quality of fish habitat and increased the potential for flooding. These effects are being studied in greater detail for Crow Canyon, as part of the Crow Canyon Watershed Science Project (Collins, in progress).

Flood Control — Urbanization

While residential development has begun to enter the canyons in recent decades, intensive urban development has already transformed the flatlands. After 50 years of cattle grazing and a century of agriculture, most of the alluvial plain was converted to residential and commercial use within a decade. Intensive development of San Lorenzo Creek's floodplain only became possible with the Army Corps of Engineers Flood Control Project. Between 1954 and 1961 the creek's lower reach was converted into a concrete flood control channel, and numerous other modifications were made between the Bay and the base of the hills. During the early 1960s, dams were also constructed on two of the main tributaries, Cull Creek (Cull Creek Dam) and Palomares Creek (Don Castro Reservoir).

In the ten years between 1950 and 1960, the population of Hayward increased a remarkable 500 percent — from 14,246 to 72,700 people. Part of the post-World War II population boom, the growth of cities here was made possible largely by the changes to the creek. Among the many major developments built in the subsequent decades was Southland, one of the West Coast's first and largest fully enclosed commercial malls.

The landscape continues to change, in response to natural processes, the human modifications, and larger climatic shifts. For example, peak flows in the creek appear to be increasing, due to development of the watershed. As a result, it is likely that the flood control channel will become less effective at restraining floods in the future. In recent years, local residents have found rainbow trout 20 inches long in the creek above Hayward, indicating that fish may still migrate up San Lorenzo Creek from the Bay, despite the changes. Interactions between the creek and its inhabitants will continue to evolve, shaping life alongside the Bay.



"MULTI-MILLION DOLLAR POTENTIAL . . . Above is 2000 acre flood plain of San Lorenzo creek which will be freed of flood threat by $369,000 channel widening and deepening project to be accomplished in the next six months by Alameda County Flood Control and Water Conservation district. Good drainage will open up the area for industrial and residential development."

Drawing on the left from a 1954 newspaper article (caption above) shows the planned flood control channel on San Lorenzo Creek, with surrounding open space and discrete townships. Photograph on the right, 50 years later, shows the completed channel and adjacent development. (Daily Review 1954 courtesy of Hayward Historical Society; aerial view on the approach to Oakland International Airport November 2003)

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